Publication SLM045
September, 2002

General Topics

A FACTSHEET SERIES ON

ENVIRONMENTAL GUIDELINES FOR LIVESTOCK PRODUCERS

CONTENTS

- 1. Introduction
- 2. Legislation/Regulations
- 3. Site Selection
- 4. Manure Handling and Storage
- 5. Land Application of Manure
- 6. Outdoor Areas for Dairy and Beef
- 7. Feed and Water for Outdoor Areas
- 8. Composting Manure
- 9. Farm Residential Sewage Disposal Systems
- 10. Disposal of Dead Animals and Other Farm Wastes
- 11. On-Farm Slaughter House and Meat Inspection
- 12. Sources of Information
- Appendix A: Odour Treatment Techniques
- Appendix B: Conversion Tables
- Appendix C: Recommended Minimum Land Area for Livestock Manure Utilization
- Appendix D: Calculating Minimum Separation Distance (MSD)
- Appendix E: Annual Livestock Manure Production
- Appendix F: Nitrogen Loss Summary

106-00284/

- Appendix G: Safety
- Appendix H: Soil and Manure Sampling
- Appendix I: A Method to Determine Manure Application Rates
- Appendix J: Guidelines for Pesticide Use
- Appendix K: References
- Appendix L: Glossary of Terms

1. INTRODUCTION

The Environmental Farm Practices Guidelines Project for Livestock Producers in Newfoundland and Labrador, November 2001, was funded by the Canada/Newfoundland Agreement on Green Plan (Sustainable Agriculture), managed by the Newfoundland and Labrador Federation of Agriculture, supported by the Newfoundland and Labrador Department of Forest Resources and Agrifoods. Gardner Pinfold Consulting Economics Ltd. and P. Jacobs and Associates Ltd. prepared the initial version of the document

These guidelines describe management systems and practices that will reduce the risk of pollution and minimize the odour experienced by neighbours. They establish acceptable farming practices for poultry producers in Newfoundland. The objectives of these guidelines are:

- to assist livestock producers in their efforts to prevent pollution and to minimize odour;
- to provide a standard that may be used by industry and government in determining normal, acceptable farming practice;
- to provide local governments with a basis for evaluation of livestock operations;
- to provide information to the general public and government officials who evaluate livestock operations for their potential effects on the surrounding area; and
- to explain farm practice to the general public with the objective of increasing the public's appreciation of the agriculture industry and an understanding of how farms operate.

Commercial dairy, hog, sheep, beef and fur farms generate nearly 40% of the total farm cash receipts in Newfoundland and Labrador. Much of this production tends to be concentrated near larger urban markets. The Avalon Peninsula, in particular, has several dairy farms operating within the city of St. John's. The potential for conflict with neighbours is more pronounced near urban centres. This potential has increased in recent years for two reasons:

1) greater concentration of production on fewer farms; and,

2) an urban population expanding into rural areas.

The general trend in modern intensive agriculture - larger numbers of animals on a smallemumber of farms - is apparent in Newfoundland and Labrador. These management practices result in the concentration of large amounts of manure, which must be effectively managed if a range of environmental, health and public relations problems are to be avoided.

The character of the expanding rural residential population has also changed. People have built or bought houses in and around land that had previously been used for agriculture alone. These rural properties represent a major personal investment and the owners are sensitive to any activity that may interfere with their enjoyment of the property, or reduces the property's value. These changes have created a situation where conflicts between livestock producers and urban-rural residents are more likely to occur.

Conflicts Caused by Pollution

The viability of the livestockindustry depends on the sustainability of the environment. Therefore the protection of the environment must be a major concern for the livestock industry. Groundwater and surface water pollution is an environmental and health concern, and is regulated under federal (Environment Canada) and provincial (the Department of Environment) legislation. Pollution of water sources is illegal, and these agencies are responsible for preventing pollution, detecting pollution if it has occurred and taking legal action if necessary.

Society is becoming increasingly concerned with environmental protection and there will be more pressure to regulate livestock operations closely if there is reason to suspect that pollution is occurring. Producers who follow the recommended practices described in these guidelines can expect to be in compliance with the relevant federal and provincial regulations.

Conflicts Caused by Odour

Although odours may be a nuisance, they are not considered a health hazard. They must therefore be treated as a land use issue. The best opportunity for avoiding odour problems occurs during land use planning, when conflicting uses can be separated. Some jurisdictions have been unwilling or unable to prevent residential development in agricultural areas. Subdivision lots are often sold to people who are unaccustomed or unwillingto accept the odours associated with livestock operations. As well, local government officialsoften lackthe resources required to evaluatemanure management practices properly. This can result in developments that lead to conflicts between rural residents and livestock producers.

Livestock odours are as much a social problem as they are a technical problem. The prudent farmer will recognize his/her responsibility to minimize odours, and the inconvenienced neighbour must recognizethat odours are an unavoidable consequence of livestock farming. Responsible day-to-day farm management and open communication within the community are probably the most significant final determinants in odour conflict avoidance.

Economics have forced most farmers to specialize in one commodity and to consolidate into larger units. The resulting high concentration of animals, manure, buildings and equipment has increased the potential for localized conflicts. Odour conflicts tend to increase as separation distances between farms and neighbouring homes become smaller.

While land use planning and public relations are methods of avoiding conflict, another process is required to resolve conflicts once they occur. In some other provinces, complaints concerning disturbances such as odour, noise, dust or smoke are dealt with under a Farm Practices Protection Act. Newfoundland and Labrador is currently considering this legislation for the province. It is the responsibility of the farm operator to maintain facilitiesand farm practices that avoid environmental problems and that fall within the current and future accepted guidelines for Newfoundland and Labrador.

These guidelines have been prepared with the assistance of Agriculture and Agri-Food Canada, the Department of Forest Resources and Agrifoods, the Newfoundland and Labrador Federation of Agriculture, Manitoba Agriculture and other provinces.

These guidelines are not legislated. They merely provide the livestock industry with various options for managing their operations in an environmentally sound manner.

As technological changes occur, revisions of the Guidelines will be necessary periodically. Your comments on this publication and future revisions are encouraged. Contact the Department of Forest Resources and Agrifoods, Agrifoods Branch at 709-637-2081 for inquiries

2. LEGISLATION/REGULATIONS

Manure management and odour control in Newfoundland and Labrador are regulated by a variety of federal, provincial and municipal acts and bylaws. Producers must understand how these laws affect their operations.

A) Federal Legislation

1. Canadian Environmental Assessment Act, S.C. 1992, c. 37

2. Canadian Environmental Protection Act

   - Environmental Code of Practice for Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products
   - Environmental Code of Practice for Aboveground Storage Tank Systems Containing Petroleum Products

3. Fisheries Act, R.S.C. 1985, c. F-14

   - Meat and Poultry Products Plant Liquid Effluent Regulations
   - Meat and Poultry Products Plant Effluent Guidelines
   - Potato Processing Plant Regulations
   - Toxicity Guidelines for Potato Processing Plants

4. Meat Inspection Act, R.S.C. 1985, c. 25 (1st Supp.)

5. Canada Water Act, R.S.C. 1985, c. C-11

   - Guidelines for Canadian Drinking Water Quality

6. The Transportation of Dangerous Goods Act, R.S.C. 1989. c. T-19

7. Canadian Environmental Assessment Act, S.C. 1992, c. 37

   - Exclusion List Regulations, SOR 94-639
   - Law List Regulation, SOR 94-636

8. Pest Control Products Act.

B) Provincial Legislation

1. Environment Act, S.N. 1995, C. E-13, which includes:

   - Storage and Handling of Gasoline and Associated Products Regulations, CNR 775/96
   - Air Pollution Control Regulations, CNR 957/96
   - The Environmental Control (Water and Sewage) Regulations, CNR 1078/96
   - Environmental Assessment Act
   - Environmental Assessment Regulations

2. Health and Community Services Act, S.N. 95, C, P-37.1, which includes:

   - Sanitation Regulations, CNR 803/96

3. Food and Drug Act, S.N. 97, Ch. F-21

   - Food Premises Regulations CNR 1002/96

4. Pesticides Control Act, RSN 1990, c. P-8:

   - The Pesticide Control Regulations, CNR 1166/96

5. Waste Material Disposal Act, RSN 1990, c. W-4

6. Urban and Rural Planning Act, RSN 1990, c. U-7

7. Municipalities Act, RSN 1990, c. M-23

8. Meat Inspection Act, SN 1997, ch M-2

   - Meat Inspection Regulations CNR 801/96

9. Lands Act:

   - Development Area of Wooddale (Agriculture) Regulations, 1996
   - The St. John's Urban Region (Agriculture) Development Area Regulations, 1996

C) Guidelines

1. Farm Practice Guidelines for Producers in Newfoundland and Labrador:

   - Livestock;
   - Poultry; and,
   - Horticultural Producers.

2. Environmental Guidelines for Agriculture Development - Livestock and Poultry Operations Less Than Five Animal Units

3. Environmental Guidelines for Agriculture Development - Non-Livestock or Poultry Production

4. Guidelines and Conditions for the Approval of Swine, Poultry and Other Livestock Enterprises

5. Information Guide for Livestock Facilities, Manure and Waste Management in the Province of Newfoundland, May 1992.

6. Newfoundland and Labrador Meat Inspection Guide, 1994

3.0 SITE SELECTION

When planning a new livestock operation or the expansion of an existing operation, the selection of an appropriate site must be given careful consideration. There are several factors that first mustbe considered when choosing a site.

- Know who is responsible for farm development in your area. In most areas of the province, applications must first be reviewed by the municipality and the Government Services Centre. Proposals are also reviewed by other provincial departments responsible for environment, agriculture, health, forestry and fisheries;

- You must contact the municipality in the early stages of the planning as acquisition of the necessary permits may take up to six months. The municipality also administers various building codes. Buildings must be designed and constructed in accordance with the Canadian Farm Building Code. You must check with your local municipal office to verify if any other provincial or municipal building codes apply. Submit building plans to the appropriate authority. For example, in the Wooddale and St. John's Agriculture Development Areas, applications for development are reviewed pursuant to regulations written to protect farms and the land base from conflicting uses of the land; and

- If you intend to develop an agricultural operation within a protected water supply, you are required to submit a five-year Development Plan to the Department of Environment. The development must not proceed without completion of an environmentally acceptable plan and written approval from the Department of Environment. For more information contact the Department of Environment. It is recommended that you consult with a Land Management Specialist, Agrifoods Branch, on matters related to development in a Water Supply. You may also find it useful to review the document, "Environmental Farm Plan Workbook" by the Atlantic Farmers Council. This document contains useful measures of environmental risk with which to evaluate your facilities and farm practices. Call the Newfoundland and Labrador Federation of Agriculture for more information on this workbook.

The provincial Department of Government Services and Lands is responsible for ensuring that existing and developing farms operate in a manner which will minimize the likelihood of pollution and the possibility for land use conflict. Both the Government Services Centre and the Agrifoods Branch require that new or expanding operations obtain a ministerial Environmental Certificate of Approval under the Waste Material Disposal Act for manure handling and storage before a farm of more than five animal units is permitted to operate (see Appendix B for metric/imperial unit conversion tables and Appendix C for a description of animal units). This certificate is prepared by the Government Services Centre and released by the Agrifoods Branch Land Management Specialist. In public water supplies, the Department of Environment also has a role in preparing this certificate.

Once these requirements have been met, careful attention must be paid in site selection to separation

distances between the livestock operation and the following structures or areas:

- neighbouring dwelling;
- residential, recreational or commercial areas;
- water supplies;
- provincial highways and roads;
- public buildings; and
- property lines.

Proximity to Property Lines, Neighbours and Rural Residential or Recreational Developments

The potential for nuisance conflicts can be minimized by ensuring adequate separation between livestock facilitiesand neighbours. Proximity to developments can determine the potential for future growth of the operation. Greater separation distances afford more opportunity for odours to become diluted by mixing with the air. The intensity of the odour is thus reduced, and the nuisance level decreased. When evaluating sites for new operations only, you must select a location that willimpact on as few neighbours as possible. Please note, proposals for new operations within 610 metres (2,000 ft) of houses, residential areas or provincial park boundaries will be reviewed by the Government Services Centre and the Agri-Foods Branch in regards to the potential for land use conflicts.

General guidelines for the minimum separation from property lines are illustrated in Table 1.

TABLE 1

Guidelines for Minimum Separation Distances Between New Operations and Property Lines[1, 2]

Barns	45 m (150 ft)
Manure storage	100 m (330 ft)

1. Agencies such as the Government Services Centre or municipalities may have other requirements.
2. These separation distances apply to new operations.

The recommended Minimum Separation Distance (MSD) between a livestock operation and single residences, residential or recreational areas varies with the following factors:

- size of the operation measured in animal units;
- degree of expansion from existing operation;

- type of manure storage;
- type of housing; and
- type of livestock.

It is emphasized that the MSD's are guidelines and that separation distances for new livestock operations may be less in legislated or designated agricultural areas. In addition, a farmer's manure management system may include a land base located away from the home farm which is used for manure spreading.

A method for calculating the MSD is presented in Appendix D. It provides a consistent and uniform technique for assessing the conflict potential of land use change involving a new or expanded construction. For non-agricultural developments, the MSD method provides a recommended minimum separation distance between new or expanding non-agricultural developments and existing livestock facilities. For agricultural developments, it provides a recommended minimum separation distance between new or expanded livestock developments and other existing uses.

In general, larger separation distances are recommended as the size of the operation increases. Municipalities may require different siting criteria from those recommended here. The location of new operations must always be cleared with municipal authorities. Municipal property ownership maps are very useful for evaluating potential sites.

Proximity to Watercourses and Wells

Plan the location of livestock facilities to maximize the separation from water supply wells. This is particularly important with field or earthen manure storages where groundwater is obtained from shallow (dug) wells or where bedrock is found close to ground surface. It is recommended that wells should be drilled rather than dug. It is recommended the water be tested twice a year for bacteria.

Minimum separation distances to watercourses and wells required for manure storages are given in Table 2. Wells must be located uphill from storages and constructed in a manner that will prevent pollutants from entering the well. Grouting the annular space outside the casing with cement or bentonite grout must be carried out where appropriate.

TABLE 2

Guidelines for Minimum Separation Distances Between Manure Storages and Watercourses and Wells
(Distance may vary depending on local conditions such as slope, drainage, land use or zoning)

Storage Type	Distance to	
	Watercourse, m (ft)	Private Well, m (ft)
Storage (synthetic or concrete)	50 (160)	50 (160)
Earthen Storage (where approved)	100 (330)	100 (330)
In a Field	100 (330)	100 (330)
Composting (no liner)*	100 (330)	100 (330)

* Liners may be required depending on the site

Proximity to Provincial Highways and Roads

The Department of Government Services and Lands regulates the placing of buildings, structures, fences, plantings and the establishment of various enterprises adjacent to many provincial roads and highways. They also control access to provincial highways and discharge of surface runoff and liquids into highway ditches.

Agricultural buildings, with the exception of residences and fruit and vegetable stands, should be located 91 metres (300 ft) from roadways unless approved by the Government Service Centre. Generally, any buildings, structures, fences and tree plantings to be located within 91 metres (300 ft) of certain provincial highways or within or up to 457 metres (1,500 ft) of major highway intersections require prior approval by the Government Service Centre. Since these distances vary from one highway to another and at different intersections, it is important to consult with the Government Service Centre early in your planning.

Site Selection for Odour Control

Odours are one of the main causes of conflicts between livestock producers and their neighbours. In most areas, livestock producers represent a small minority of the population. It is, therefore, essential that producers develop and maintain a good image within their community. It is unrealistic not to expect a commercial livestock operation to operate with some odour. The nuisance level can, however, be significantly reduced when livestock farms are properly sited, designed and operated.

The potential for odour problems can be minimized by considering the use of bush and windbreaks and accounting for prevailing wind direction. Take advantage of natural terrain and landscaping to minimize conflicts with neighbours. Since every situation is unique, the most practical approach is

to evaluate the situation with the assistance of an agricultural engineer and the Land Management Specialist for your area. The Land Management Specialist will be familiar with the zoning for the area and know of proposed subdivisions. The Land Management Specialist can assist in obtaining climate data and interpret the information for a particular site. The prevailing wind direction can vary between seasons. Since summer is the time when odours are more intense and neighbours are outdoors more often, it is important to consider the direction of the prevailing winds for the summer.

Separation distances between new livestock buildings and non-agricultural uses should also be a consideration in selecting a site. Guidelines for minimum separation distances based on the size and type of the farm, along with land use considerations, appear in Appendix D.

4.0 MANURE HANDLING AND STORAGE

Solids Content

The type of equipment used in a manure handling system depends on the solids content. Livestock manure is classified as either a solid, semi-solid or liquid using the following criteria:

1) Solid – The manure's solid content is greater than 20%. The use of bedding material further contributes to the solids content of the manure. To produce a solid manure, the liquid must be drained off and the manure dried or bedding added. At this consistency, the solid manure can then be stacked.

2) Semi-Solid (also referred to as slurry) – Contains 5% to 20% solids.

3) Liquid – Contains less than 5% solids. The additional liquid comes from washing and milking house waste water.

System Components

The elements of a manure management system include collection, transfer, storage, treatment, utilization and disposal. The components of the various systems for solid, semi-solid and liquid manure are summarized in Table 3 and further discussed below.

1) Solid Manure Systems:

Manure from tie stall or neck chain dairy operations is typically handled as a solid due to liberal amounts of bedding mixed with the manure. These barns normally have a gutter cleaner for collection and then either a conveyor or pump to transfer the manure outside to the storage area. Regular cleaning of the barn is also important to a successful fly control program. Other fly control measures include removing wet feed during fly breeding season, disposing of dead animals and afterbirth and keeping manure storing areas dark. You can also store manure in enclosed structures, protect ventilation inlets with screens and regularly spray with approved insecticides.

Manure from most types of beef operations is handled and stored as a solid, mostly on a slab or on the ground. The manure and bedding accumulates in the barn until it is periodically removed. Front end loaders are normally used to remove the manure from the barn and transfer it to the storage area.

Hogs are generally housed in barns with a pen system based on concrete floors. Hog manure can be handled as a solid because of the bedding mixture (sawdust, wood shavings, etc.) but commercial operations generally use a liquid manure system.

Fur farms generally house fox and mink breeders in outdoor pens with a wire base or inside small buildings or barns. In outdoor systems, the manure falls through the mesh to the ground below. The manure is then manually handled and taken to the manure storage areas, which is generally outdoors. Manure produced in indoor systems is handled in a similar fashion. Since the quantities of manure is small on fur farms, it is appropriate for farmers to compost the manure for spreading at a later date. In other situations, operators who are not running mixed enterprises may have other livestock operators handle their manure for spreading on farm land.

2) Liquid or Semi-Solid Manure Systems:

Manure systems for free stall dairy barns are usually designed for semi-solid or liquid manure. These systems do not involve the use of any bedding material. Manure is either collected under slatted floors or with the use of scrapers. It is then held in a pit under the floor or is transferred to long-term storage utilizing conveyors, gravity flow pits or pumps. Currently, only a small number of dairy farms are using free stall facilities in the province.

TABLE 3

Components of a Manure Handling System for Various Types of Wastes

Operation	Solids	Semi-Solid/Liquids
Collection	Gutter Cleaners Front End Loaders	Slatted Floors Scrapers cable or hydraulic tractor
Transfer	Manure Wagons Open Tank Spreaders Dump Trucks Earth Moving Equipment Conveyors Pumps	Pumps submerged, open impeller piston pneumatic Augers Vacuum Tank Wagon Pipeline Gravity Continuous Flow Gutters Large Diameter Pipes
Storage	Stockpile Bunk Silo	In-Building Below Ground concrete (open/covered) earthen Above Ground concrete/glass lined steel

Operation	Solids	Semi-Solid/Liquids
Treatment	Aerobic compost dry incinerate	Aerobic pre-storage partial total Anaerobic Solid/Liquid Separation
Utilize/Disposal	Land Application Energy Production Bedding	Land Application Irrigation Energy Production

Source: Farm Practices Guidelines for Dairy, Beef and Hog Producers in Manitoba.

Equipment Selection and Maintenance

Regardless of the type of manure being transferred, it is important to use equipment designed for that purpose and to operate and maintain the equipment according to manufacturer's instructions. The equipment must be capable of functioning reliably in a corrosive environment. Equipment also requires proper maintenance if it is expected to have a long service life. Although maintenance of manure handling equipment may be unpleasant, a disruption of spreading due to major repairs is a greater inconvenience and may lead to problems with neighbours.

Preventative maintenance and the use of reliable equipment are critical for avoiding problems when handling manure. For example, a flat tire on a manure spreader may present serious problems. Often the spreader must be emptied before the tire can be repaired. Unless the flat happens near the manure storage it may be difficult to empty the spreader without dumping the manure in an unacceptable place. Another example could be a valve on a manure tank that does not close properly may allow manure to spill onto a public road during transportation.

Pumps used in liquid systems require some method of screening out solid materials. Problems occur when ear tags, hair, tails, teeth and other objects enter the pump. In slurries, solids will separate from liquids during storage, therefore, some agitation is required to bring the solids back into suspension. Chopper pumps are appropriate since they do not easily become plugged with hair, etc. These agitation pumps have capacities of about 200 litres (44 gallons) per second. Pumps used for irrigation, on the other hand, may range in capacity from 20-60 litres (4.4-13.2 gallons) per second and can transfer manure up to 1.25 kilometres (.775 miles) through irrigation pipe.

While liquids are transferred by gravity or pumps, solid manure is usually transferred by conveyors, augers, piston pumps or front end loaders.

Livestock Housing Management for Odour Control

Very little odour is given off by fresh manure. Once the manure starts to decompose, odour production begins. Inside a livestock building, even small deposits of manure are a likely source of odour. Solid manure tends to form fewer odours than liquid manure. By keeping conditions dry, the production of odour is reduced. Good housekeeping is the best management method.

The following guidelines for livestock housing management are recommended:

- collect and transfer manure from the barn to storage on a daily basis or every few days. Daily clean-out will significantly reduce the production of odours from manure in the building. If a hard-pack system of maintenance is used, ensure that sufficient bedding is added to absorb liquids;

  Fur farms can minimize odours by regularly cleaning pen areas during the growing and furring periods in the summer and fall. However, the need to minimize disturbances during breeding and whelping in the late winter and spring makes regular cleaning more difficult. Fortunately, fewer animals on the farm during these times helps to minimize the potential for odour;

- avoid ponding of effluent due to poor drainage or bad concrete work. Maintain bedding in a dry condition to avoid mold and dust and loss of absorbing capacity;

- maintain watering systems to prevent water from being added needlessly to manure and bedding. Use an appropriate combination of hose, pressure and nozzle in order to clean buildings with a minimum amount of water. Low nozzle pressures require excessive amounts of water and high pressures cause manure to be sprayed onto building walls where they can remain and be a source of odour;

- if applicable, thoroughly clean and disinfect buildings between successive groups of livestock;

- do not surpass recommended animal densities for livestock buildings; and

- remove dust, clean ventilation fans and shafts. Keep dust levels low since odours are absorbed and carried in the air on dust particles.

Ventilation of farm buildings, in addition to controlling the temperature and humidity, also controls the production and build-up of poisonous and odourous gases. The following guidelines should be observed:

- maintain maximum air flow through livestock buildings. This will assist to keep conditions as dry as possible and will promote aerobic conditions so that fewer odours are produced. It is also effective in diluting odourous gases as they are released to the outside environment; and

- maintain and repair ventilation fans and check that they have the appropriate capacity for the number of livestock being housed in the building. For livestock comfort, low level winter ventilation must be continuous, and in summer, thermostats must be used to control the higher ventilation rates that will be necessary. Foxes and mink, which are generally raised outdoors, may produce stronger odours during mating season that can increase the chances of nuisance to nearby residences. While maintaining clean conditions for these animals will help to minimize this nuisance, good neighbour relations are very important in

avoiding conflicts*.

The position, design and height of exhaust outlets affects the dilution of odourous gases outside of livestock buildings. In general, higheroutlets provide greater dilution of exhaust gases. Options for ventilation design may be discussed with experts in the field.

Exhaust gases from livestock buildings may be treated for odour control as part of the ventilation process. Treatment requires additional expenditure, but may be warranted in certain circumstances. For these methods to be effective they must be designed and installed correctly. Qualified professionals should be consulted.

* *N.B.* *It is important the general public understand that from time to time, farm activities associated with commercial livestock farmers, will produce farm odours, noise, dust, etc. which are a normal part of farming.*

4.1 Planning A Manure Storage

A storage facility is a permanent structure or location designed and operated to contain manure in an environmentally sound manner for the period of time required to allow the manure to be used as an organic fertilizer. The design of the storage will depend upon:

- the location of the storage;
- the storage capacity required for the livestock operation;
- the characteristics of the manure (such as the amount of solids); and
- the methods of filling and emptying.

Although some design considerations are discussed, producers are advised to contact an agricultural engineer for complete design information. Manure storage structures must also provide the following:

- flexibility for timing manure spreading;
- sufficiently impervious to prevent leakage; and
- an appropriate level of odour control.

All manure storage systems must be evaluated to ensure pollution is not occurring and that the facility meets the requirements under the various acts and legislationexisting in Newfoundland and Labrador. Furthermore, if there is insufficient land on the farm to handle the manure, the operator must supply written commitments ensuring that the manure will be removed and used in a fashion acceptable to the Government Services Centre. This issue is addressed in Section 5.4, Acceptable Application Rates.

4.2 Location

In order to minimize any risk of pollution, all manure storages are required to meet the minimum separation distances discussed in Appendix D. Groundwater and soil conditions must be evaluated to ensure that the site is suitable for the type of storage planned. For example, where the groundwater levels are near the bottom of the storage, do not use an earthen storage without a suitable liner (for example, a flexible membrane, concrete or equivalent material). Refer to Section 4.6, Liquid Manure Storage for further information on earthen manure storages.

The site for the storage must provide the following:

- the storage must be located close enough to the barns to allow for convenient filling and still permit expansion of the facilities;
- it must be accessible by an all weather road for field spreading equipment;
- if possible, it should be located out of sight of the road and dwellings;
- the storage must be located to avoid collecting surface and roof run-off; and
- manure storage systems must not be constructed on the banks of water bodies, including rivers, drainage channels, ponds and wetlands (bogs and fens). A buffer of 50 metres or more is recommended.

Despite the fact that it is generally accepted that manure from some types of livestock operations does not stockpile well, some producers have accumulated stockpiled manure that is not regularly spread on land or sent for other uses. This can lead to environmental problems. To avoid these problems:

- maintain proper separation distances to surface water and with neighbour's land uses;
- stockpile the manure in such a manner as to minimize the likelihood of leaching and run-off;
- do not be stockpile manure over field drainage tiles;
- ensure the length of time of field storage does not exceed six months (The Canadian Code for Environmentally Sound Hog Production, Canadian Pork Council); and
- do not dump manure in coastal waters or wooded areas (this is prohibited in Newfoundland and Labrador unless by special permit).

Install a groundwater controlling drain around the manure facility to prevent the entry of groundwater into both earthen or concrete storages. For earthen structures, this drainage prevents groundwater from entering the storage. Groundwater reduces storage capacity and weakens the manure sealing capacity by lowering the total solids content. For concrete structures, this drainage prevents frost heaving, reduces external groundwater pressure when the storage is empty and prevents water entry.

In order to minimize any risk of pollution, all manure storages are required to meet the minimum separation distances discussed (Appendix D).

4.3 Size

Manure storage requirements for livestock farms depend on:

- management practices and facilities;
- the type and number of animals;
- the amount of water from spillage or from washing;
- the length of storage time needed;
- the amount of precipitation and/or groundwater added to storage contents;
- the amount of dilution water added;
- the amount of evaporation;
- the amount of bedding material used; and
- additional freeboard, also known as unused manure storage space. (Newfoundland guidelines are 60 cm (2 feet) for earthen storages or 45 cm (1.5 feet) for concrete manure storages)

The storage must have some reserve capacity to allow for the accumulation of solids and for precipitation. When the storage is ready for clean out it must have enough capacity to handle a major rainstorm without overflowing. This is especially important for the east coast of Newfoundland which receives higher rates of precipitation.

In dairy operations, milkhouse (milk centre) wastewater may need to be considered in determining manure storage capacity. In farrowing and nursery operations where washing is performed regularly, the volume of liquid manure may increase by two or three times. Similarly the use of water conserving devices such as wet/dry feeders can decrease the amount of water used by livestock by up to 40% when compared with standard drinkers. If bedding is used in solid systems the weight of manure may increase by 20% and the volume may double.

It is important to estimate manure production rates accurately, especially for expensive covered concrete systems. An agricultural engineer should be contacted to assist in the evaluation of these systems. A useful guide in preparing your estimates is the following equation:

Storage Volume Required = (Manure Volume + Bedding Volume + Wastewater including Milk Centre Volume (The amount of milking centre wastewater generated depends on the cleaning methods for floors and udders and the milking system. Water conservation measures such as using effluent water from a milk tank pre-cooler can greatly reduce the amount of wastewater created in the milking centre. Source: Environmental Guidelines for Manure Storage, Newfoundland and Labrador Department of Forest Resources and Agrifoods.) x (days of storage period)...

+ Precipitation Volume (if an open storage)...

+ Runoff Volume (if applicable) from roofs...

less Evaporation Volume (approx. 10-20% of precipitation in Newfoundland and Labrador)

In preparing your estimate of storage requirements, consider the following:

- examine a facility similar to that being proposed;
- use the above formula and the guidelines for manure production shown in Appendix E; and/or
- contact one of the resource groups listed in Section 12 (Sources of Information).

Overflow of the manure storage is a serious environmental concern and therefore is prohibited. Livestock producers must construct sufficient storage capacity to eliminate the need for winter manure spreading. A minimum storage capacity of 180 days is required by the Department of Environment. Storage capacity of 200 or more days is recommended. (If the circumstances of lot layout and adjacent land use/land ownership prevent the construction of a manure storage with this capacity, the farmer will have to implement a manure management/storage plan acceptable to the Government Services Centre and the Agrifoods Branch in consultation with the local municipality.) This will also help to minimize the extra management time, labour time and equipment use associated with short term storage. It also provides flexibility in:

- poor weather conditions;
- labour shortages; and
- equipment breakdowns.

As mentioned earlier, manure production for fur or other small livestock operations is not great and therefore poses less environmental risk, especially if the manure is disposed of in an approved and appropriate manner.

4.4 Solid Manure Stockpiles

Solid manure containing larger amounts of bedding is often stored in stockpiles. These storages must:

- be constructed and managed to contain all seepage and runoff;
- be constructed to help divert away or contain runoff from surrounding areas (this has the added benefit of minimizing manure volume);

- contain a concrete bucking wall to assist fillingthe bucket if emptying with a front end loader;
- provide access for unloading and haul out equipment; and
- depending on soil conditions, be constructed with a sloping concrete slab to prevent seepage and facilitate collecting the liquid runoff which can then be collected for removal by vacuum tanker or transferred to a separate storage.

4.5 Semi-Solid Manure Storage

Wet manure and liquid runoff can be contained by a storage consisting of earthen dykes in combination with a reinforced concrete wall. Seepage can also be controlled by a concrete slab, depending on soil conditions at the site. By sloping the slab to the corner opposite the entrance ramp, excess liquids can be removed by vacuum tanker or transferred to a separate storage.

A ramp entrance provides access for the front end loader or other removal equipment. This entrance ramp must be crowned to prevent surface water from the yard entering the storage.

4.6 Liquid Manure Storage

Livestock manure is sometimes stored as a liquid by adding dilution water to facilitate pumping. Liquid livestock manure can be stored in three types of storages:

- concrete tanks below ground;
- lined earthen storages; or
- concrete or steel tanks above ground.

All barns with a proposed system of manure washdown should ideally have a water meter to monitor the volume of water used.

A) Concrete Tanks Below Ground

The two main benefits of a concrete manure storage include:

- reduced loss of valuable nutrients (see Appendix F for a comparison of losses from different systems); and
- odours are generally not released except when the manure is agitated before the storage is emptied.

Concrete tanks are more costly than earthen storages, but because they are impermeable, they are suitable for use in areas having sandy soils. In areas with a high water table level, above ground tanks are preferable. There are also a number

of synthetic materials designed for use in earthen storages that provide impermeable barriers without the high costs of concrete storages. These are discussed under the section on earthen storages.

Concrete tanks must be designed to withstand all earth, hydrostatic and live loads. In planning the design of the storage, carefully consider the following:

- how the manure is to be agitated (please note that minimizing agitation reduces odours produced during transfer);
- there must be sufficient access ports for the pump if the tank is to be covered;
- liquid manure tanks connected to animal buildings must have gas traps or valves between them to prevent gases from entering the building;
- openings must be covered with grills or covers (these covers must weigh at least 20 kilograms (44 pounds) so they cannot be removed by children or displaced by animals and be of sufficient design so they can not drop through the opening-permanently secure covers with a safety chain);
- open tanks must be surrounded with a fence (at least 1.2 metres or 4 ft high except where the tank walls extend this distance above the adjacent ground level) to prevent accidental entry into the pit;
- agitation is more effective when large tanks are divided into a series of compartments;
- warning signs must be installed near all covered tanks to warn about noxious gas hazards; and
- a groundwater controlling drain must be installed around the manure facility to prevent the entry of groundwater into the storage. Groundwater reduces storage capacity and weakens the manure sealing capacity by lowering the total solids content. For concrete structures, this drainage prevents frost heaving, reduces external groundwater pressure when the storage is empty and prevents water entry.

You must wear a self-contained breathing apparatus when entering indoor or covered storage tanks. The manure tank must be ventilated with a fan 30 minutes prior to entry and thereafter continuously while any person is in the tank. Wear a safety harness and have on hand two people capable of pulling you out in case of emergency. Never use open flames while inspecting or working in an unventilated storage tank-some manure gases, especially methane, can be explosive. The hazards of dangerous gases are described in Appendix G, Safety.

B) Earthen Storages

Earthen storages can be used for storing liquid manure. The attraction of an earthen manure storage is its low capital cost. Unfortunately, this type of structure is responsible for the most complaints since the manure in these facilitiesis kept under anaerobic conditions and the large exposed surface area permits large quantities of odourous gases to be released into the air. The odours are generally worst when the manure begins to warm up in the spring. Other disadvantages include:

- the risk of seepage if constructed in improper soil conditions;
- the nutrient loss and the maintenance requirements;
- they should not be used in densely populated areas (see Section 3, Site Selection);and
- open storages such as this can be dangerous to children and animals (although the crusted surface may appear solid, it will not support a person).

Several considerations in designing earthen manure storages include: (Siting criteria taken from Manure Management Guidelines for New Brunswick, New Brunswick Agriculture and Rural Development, November 4, 1996.)

- the storage must be constructed to be compatible with equipment used for emptying, agitating and maintaining the slopes;
- earthen storages for liquid manure must be lined. This applies to facilities constructed after the approval of these guidelines.
- A maximum permeability of 10^{-7} cm/sec. should be used as a criteria when considering a site for an earthen facility. A hydrological assessment must be conducted before such a facility is constructed.
- locate the earthen storage in areas where the depth to the bedrock exceeds one metre for clay soils and three metres for sandy or loamy soils;
- the base of the earthen storage should be a minimum of one metre above the level of the high water table;
- install a groundwater controlling drain;
- provide a berm width of at least 3.0 metres to allow access for tractors and pumps;
- the slope of the sides must not exceed 1.5:1 (run to rise) in parent soil or 2:1 where a clay liner exists (outside slopes must be seeded to grass and maintained);

- the lateral distance from an earthen storage to a subsurface drain must be a minimum of 15 metres (50 ft);
- install concrete pads below inlets and at agitation points to reduce erosion of the bottom;
- plant shelterbelts to screen the storage from view;
- install fencing around the storage for safety; and
- install a groundwater controlling drain around the manure facility to prevent the entry of groundwater into the storage.

Earthen manure storage facilities have been accepted as environmentally safe as long as the soil used to build them contains at least 15% clay content. However, as mentioned, new facilities must comply with the maximum permeability as previously stated. Coarse sands and gravel are not considered environmentally safe and must be lined with an artificial seal. Products composed of bentonite (a fine clay material which mixes with the soil to form a liner) or other materials such as synthetic and plastic membranes, geotextiles, bentonite-geotextile membrane, asphalt concrete and asphalt can be used as earthen manure storage liners. For more information on the various earthen manure storage liners contact the structural and environmental specialist within the Department of Forest Resources and Agrifoods. You can obtain more information on the various liners by contacting the Eastern Canada Soil and Water Conservation Centre in Grand-Falls, New Brunswick (506-475-4040) or the Agricultural Engineering Department of McGill University in Ste. Anne de Bellevue, Quebec.

C) Concrete Tanks Above Ground

Above ground tanks can be either circular silo type with an open or enclosed top or rectangular structures. Depending on the size, the silo structures are generally more expensive than in-ground concrete tanks. Because of the cost, these systems are generally not used to store diluted wastes. This type of storage may be the only choice in conditions where space is limiting or where soil conditions do not permit the use of an in-ground storage. A benefit of this type of structure is that the small surface area may permit formation of a crust on top which would reduce odour production considerably.

The storage may be constructed from concrete staves, reinforced cast-in place concrete, glass lined steel panels or spiral wound coated steel. Some tanks are equipped with filling and agitation equipment designed specifically for that purpose.

4.7 Milkhouse Waste

Milking house wastes contain many ingredients that may affect the environment. Milking house wastes may include manure deposited in the milking parlour, udder washings, spilled milk, and equipment wash water containing detergents, acids and chlorine.

Milking centre sanitation and the handling of dairy waste water are controlled by the Government Services Centre. Additional legislation which may have relevant sections is listed in Section 2. The following points are made to assist dairy producers in choosing a waste water handling system:

- on dairy farms where manure is handled as a liquid, milking house wastes should be directed to the manure storage facility. This volume can be significant, 8 to 20 litres (2 to 4 gallons) per milk cow per day. Therefore, care must be taken to ensure that sufficient storage space is available to handle this additional volume. See Section 4.1 Planning a Manure Storage;

- pretreatment guidelines for washwater before discharge from the milking centre include never allowing more than 4.5 litres (1 gallon) of milk per day into the milkhouse wastewater, no more than 13.5 litres (3 gallons) of water is used per cow per day for cleanup and the water must be tested once a year to balance the use of cleaning products and disinfectants; taken from Atlantic Environmental Farm Plan, Second Edition, Atlantic Farmers Council.

- on farms that currently handle wastes as a solid or semi-solid, additional liquid is not wanted in the manure storage facility. In these cases, separate liquid storage for milking centre wastes will be required; and

- Although suspended milk solids in milking centre wastes tend to clog the tile field and, as a result, tile fields often fail within five years of installation, at present this is still considered the best disposal system next to disposal in the manure storage facility.

4.8 Manure Storage for Odour Control

Most odour-causing gases are formed when manure is in storage. In practice, most manure storage is anaerobic (meaning in the absence of oxygen). The anaerobic conditions promote odour production. These gases either escape from the storage to cause immediate problems or are released later during spreading.

Typically fewer odours are produced by solid manure handling systems than by liquid systems. An undisturbed solid manure stack is self sealing so few odours are given off until the pile is disturbed. With open liquid storage, odours are common. Weather as well as the addition of manure can agitate the slurry causing gases to be given off.

Covered storages are an effective way to minimize odour generation. Storage covers:

- reduce occasional manure agitation caused by wind and rain;

- reduce the movement of odourous air from storage areas to neighbouring residences; and
- reduce the addition of water from rain and snow thereby also reducing the total volume of manure to be spread. While in most instances the cost may preclude covering storage areas, in certain circumstances this expense may be justified.

When evaluating manure storages, consider the following guidelines to reduce the potential for nuisance odours:

- provide additional storage volume for greater flexibility in the timing of manure application. This can reduce the likelihood of storage overflow and permit application to coincide with the most appropriate timing and weather conditions;

- with solid and semi-solid manure management systems, separate the liquid and solid portions of manure in storage to reduce the promotion of anaerobic conditions;

- avoid the addition of silage effluent and waste food products to the manure storage reservoir. These combinations create strong odours; and

- planting a buffer zone of trees around manure storage areas will reduce the movement of air over the manure surface, thereby lowering the amount of odour released. This has the added benefit of removing the storage from the sight of neighbours and improves the image of the farm by providing a pleasant, aesthetically pleasing appearance.

Treatment of manure before it enters long term storage avoids odour problems in storage and during spreading. Treatment systems must be designed to handle the manure volumes generated by the livestock operation. An improperly designed or managed treatment facility will prove unsatisfactory. Often treatment is performed in short-term storage so less expensive reservoirs can be used for the larger, long-term storage. Some treatment methods for odour control are listed in Appendix A. It is important to note these treatments are mostly used in rare cases when dealing with severe odour problems.

4.9 Alternative Manure Storage Systems

Most barns in livestock operations with liquid manure systems are presently designed with shallow pits that are emptied frequently. Other systems are available that have better odour control than shallow pits, but the equipment and labour costs have limited their acceptance in Newfoundland and Labrador. The following is a brief description of these alternative systems.

1) **Solid/Liquid Separation.** The rate of decomposition can be limited by separating the solid and liquid parts of the manure. Separation can be achieved through the use of:

   a) specially designed manure pits, with the liquids continuously drained to storage and the solids scraped out of the barn each day; and/or

   b) mechanical screens or filters.

2) **Bedding-Based Systems.** The use of bedding such as straw, sawdust or shavings can maintain aerobic conditions if enough material is used and the bedding is changed frequently. You must be aware that the labour requirements for materials handling is high but odours can be minimized effectively. Currently, little straw is

grown or used as bedding in the province of Newfoundland and Labrador. Many livestockproducers instead use sawdust, wood shavings or in some cases, shredded paper as bedding. Peat may also have potential as a bedding material. Experiments in the poultry industry may help determine its applicability to livestock operations.

3) **Modification of Exhaust Air.** Attempts have been made to reduce the odour levels of exhaust ventilation air by removing the dust from the air. While odour levels can be reduced, such systems are expensive to construct and maintain.

5.0 LAND APPLICATION OF MANURE

Manure – A Sustainable Resource

Spreading manure on land is a highly desirable method of recycling a natural, organic by-product of livestock production. Land application of manure has many benefits:

- it is readily available on livestock operations with minimal energy input;
- many livestock operations are surrounded by large areas of productive agricultural land that can benefit from its use;
- land application can significantly decrease crop production costs (fertilizer) by providing plant nutrients; and
- manure acts as a valuable soil amendment when properly managed by adding organic matter which improves soil tilth, structure, aeration, water holding and warming properties (organic matter affects soil color, reduces soil stickiness and helps to control soil erosion).

Manure is an excellent fertilizerthat poses an environmental risk only when mismanaged. Too much of a good thing, however, can lead to problems such as damage to crops or the risk of pollution. Soil assay tests must be carried out before manure spreading is undertaken to ensure the nutrients applied meet only the soil requirements for beneficial use. Once these results are known, there are two main strategies for manure use on land: maximum nutrient efficiency or maximum application rates. (Source: Best Management Practices: A Manure Nutrient Management Program, Ohio State University Extension, Department of Horticulture and Crop Science.)

If maximum nutrient efficiency is the goal, rates of application need to be based on the nutrient present at the highest level in terms of the crop needs. In many cases, this is phosphorous. Manure must be applied at a rate which willmeet the crop requirements for phosphorous. Additional nitrogen and potassium can be supplied with commercial fertilizers. This strategy is least likely to cause undesirable environmental effects and makes the most efficient use of all nutrients in the manure.

The other strategy for utilizing manure on cropland is to determine arate of application which will satisfy the crop's requirement for nitrogen without causing environmental problems. This strategy maximizes the rate of applications, making less efficientuse of phosphorous and potassium than the first strategy outlined above. It is important to note that a manure application strategy based on crop nitrogen requirements will lead to an accumulation of potassium in the long term, especially with repeated applications. Excessive levels of potassium in soil can result in surface water quality problems.

The goals of every livestock producer must be to:

- minimize the nuisance created by spreading manure;
- maximize the utilization of the manure nutrients by crops; and,

- minimize the risk of polluting surface waters and groundwater.

One of the easiest ways of achieving these goals is to incorporate the manure into the soil if at all possible. Every possible effort must be made to incorporate manure into soil within 48 hours of application. If incorporation is not feasible such as on perennial forage crops then apply manure under favourable weather conditions, when possible.

Some livestock operations do not have an adequate land base to dispose of the manure that they generate. In these cases, it is the farmer's responsibility to identify other producers with an adequate land base who are willing to accept responsibility for the volume of manure being generated.

Increasing amounts of inorganic fertilizers (chemical fertilizers that are either mixed or manufactured) are also being used in the production of horticulture crops in Newfoundland and Labrador. The benefits of using inorganic fertilizers include consistent analysis and ease of handling. You must ensure that elements found in commercial fertilizers do not accumulate in the soil to high concentration levels. Base the amount of inorganic fertilizer used in your operation on soil analysis and follow recommendations for fertilizer use.

Application of other natural fertilizers such as fish offal, kelp, crab shells and similar materials is regulated under the Waste Disposal Act and subject to the approval and conditions of the Government Services Centre. Marine products must be turned into the soil within 24 hours unless the Government Services Centre is satisfied the remoteness of the site will not likely result in conflicts. These are sometimes added to the soil as a conditioner and can cause odour problems. The soil or crop specialists with the Agri-Foods Branch can provide advice on the use of natural fertilizers and compost.

Manure as a Fertilizer

When considering manure as a fertilizer the important characteristics are:

- nitrogen content;
- phosphorous content;
- potassium (potash) content and minerals such as sulphur;
- micro-organisms; and,
- organic matter content.

Nitrogen, phosphorous and potassium are the three main nutrients found in manure used for plant growth.

a) Nitrogen

Nitrogen promotes rapid vegetative growth and gives plants their healthy green colour. To maximize the fertilizer value, manure must be stored and handled to reduce nitrogen losses. This is important since nitrogen in manure exists in two forms:

- the largest portion is contained in the complex molecules of digested feed and is known as organic nitrogen; and,
- ammonium nitrogen and nitrate-nitrogen (the general assumption for Newfoundland and Labrador is that ammonium nitrogen equals 50% of total N and nitrate nitrogen equals 5% of total N).

Organic nitrogen is not available for use by plants until it mineralizes to the nitrate form, the same form as the nitrogen in some commercial fertilizers. The rate of mineralization will depend on the composition of the manure, soil type, temperature and moisture content. Generally, 30 to 50% of the nitrogen will be mineralized during the first cropping season with the balance mineralized during the next three years.

Nitrate-nitrogen is dissolved in water and can move away from the root zone in the soil. This process is known as leaching. When manure is handled and spread on land, some of the nitrogen in the manure that exists as ammonia gas will be released to the atmosphere. It is important to minimize the time of exposure by incorporating the manure into the soil as quickly as possible. Most nitrogen losses occur within the first 24 hours after the manure is spread due to volatilization.

Nitrogen can be conserved by using the following practices:

- transfer the manure from the barn to storage as often as possible, especially during the summer;
- use transfer systems such as bottom loading storages that minimize contact between the manure and the air;
- use storage facilities with a minimum of exposed surface area, or cover the manure storage to reduce contact with air;
- when spreading manure, minimize the time of exposure by incorporating the manure into the soil as quickly as possible; and,
- limit the application rate to avoid ponding.

Typical nitrogen losses for various methods of spreading are listed in Appendix F.

b) Phosphorous

Phosphorous stimulates early growth and root formation, hastens maturity, promotes seed production and makes plants hardy. The phosphorous in manure exists in both the organic and inorganic forms, but unlike nitrogen, phosphorous is not released to the air. As with nitrogen, the inorganic form is readily available to be used by plants, but the organic form is not available until the phosphorous is mineralized. Phosphorous is not removed from the root zone unless very high levels build up in the soil. Most phosphorous loss is due to soil erosion.

c) Potassium (Potash) and Minerals such as Sulphur

Potassium improves the plant's ability to resist disease and cold and aids in the production of carbohydrates (energy producing organic compounds). Potassium is especially important for stem strength in grasses. Sulphur is needed in small amounts and is essential for protein production.

Manure potassium, chiefly present in the urine, is equivalent to fertilizer potassium and is available for plant growth in the year it is applied. It accumulates in the soil which is generally desirable because it supplies the plant needs. Like phosphorous, however, potassium can accumulate to excessive levels and have detrimental effects on plant growth.

d) Micro-organisms

Although manure contains large numbers of micro-organisms, very few can carry diseases to people. The micro-organisms that carry or cause diseases are known as pathogens. The easiest transfer of pathogens from animals to people is through direct contact. The potential for disease transmission is very low since pathogens are rapidly destroyed by drying and exposure to sunlight. Proper preparation of food including the use of clean water further minimizes the likelihood of contaminating food.

e) Organic Matter

Repeated long-term application of manure at reasonable rates will add organic matter to the soil thereby improving soil tilth, structure, aeration, water holding properties and reduction of susceptibility to soil erosion.

When fields are cropped, a portion of the organic matter is removed from the field. The use of commercial inorganic fertilizers does not replenish the lost organic material. Depending on the soil type, a steady depletion of soil organic matter can result in a soil structure that is more susceptible to erosion and one

which requires high levels of fertilizer to maintain adequate levels of fertility.

For more information on organic matter see the document, Farm Practice Guidelines for Horticultural Producers in Newfoundland and Labrador.

Prevent Pollution

A portion of the nutrients in livestock feed is not used by the animal and is excreted in the manure. The nutrient content of livestock manure depends upon the age of the animal, the feed type and the manure management system.

The composition of the manure can vary with the following factors:

1) Animal Age – Manure contents are the products remaining after digestion. Animals that are growing will utilize some nutrients more efficiently than mature animals.

2) Feed Type – If the feed is in a form that does not permit the animal to digest all of the nutrients, the undigested nutrients will be excreted in the manure. Similarly, if a ration is unbalanced, the animal will not be able to use all of the nutrients and excess nutrients will be excreted.

3) Manure Management System – Depending on how the manure is stored and spread on land, some of the nutrients may be lost. The amount of straw or shavings added as bedding will change the manure properties. Some common types of organic bedding materials are straw, sawdust, sand, shredded news prints, composted manure solids, rice hulls, etc. Sand provides a comfortable bedding surface for larger animals such as dairy cows. It drains well and, unlike organic bedding, does not provide a conducive environment for mastitis causing micro-organism proliferation. Sand, however, is incompatible with gravity flow or slatted floor manure systems as it tends to settle down in storage and clogs pipes.

The methods of handling, storing and spreading manure also affect the final nutrient content. Nutrients such as nitrogen, phosphorous and potassium not used by the animal are returned to the soil where they are used by the crop. However, when proper management is not used in spreading manure, erosion, runoff and leaching may transfer the nutrients away from the soil and into water sources, causing pollution.

5.1 WATER POLLUTION

Pursuant to Section 10(2) (a) of the Environment Act, SN 1995, C. E-13, no person shall place, deposit, discharge or allow to remain within a protected water supply area any material of any kind that might impair the quality of the water. You must exercise great care when handling and applying pesticides, fertilizers or manure in water supplies.

There are a number of serious effects when water is polluted by manure:

- water quality is affected (turbidity, colour, suspended solids, nitrate or ammonia,

phosphorous, potassium and pathogens);

- ! the organic material in the manure will decompose and consume the dissolved oxygen in the water, possibly resulting in the death of fish;
- ! settled solids and nitrogen compounds can kill aquatic life forms;
- ! nutrients in the manure may increase the growth of aquatic plants that can disrupt the ecosystem of the water body;
- ! bacteria and viruses may be introduced, increasing the potential for spreading diseases; and,
- ! excessive nitrates in drinking water can create a health hazard for humans (especially in young children) and reduce the performance of livestock.

You must ensure that manure storages are secure and that land spreading is performed at proper rates so that water sources are not polluted.

Soil Pollution

Over-application of manure to soils can result in the build up of nutrients in the soil. When the nutrient concentrations become too high, nutrients such as nitrate-nitrogen can move through the soil to groundwater. A prolonged over-application of manure can lead to an imbalance in the soil chemistry which will result in reduced crop yields. High concentrations of manure are toxic to plants. After one year's manure application, grasses, root crops or some type of flora must be planted to take up the nutrients applied to the soil.

Minimize soil compaction by not driving repeatedly over the area of the field with heavy tanks of manure.

5.2 SEASONAL CONSIDERATIONS

The timing of manure spreading throughout the year is important. Manure will gradually decompose in the soil zone. As decomposition occurs, nutrients from the manure become available for use by the plant. These nutrients, however, also become susceptible to losses through leaching or runoff depending on the time of the year, weather and soil conditions.

1) Spring may be the best time to apply manure, since the crop will be able to use the nutrients as they become available. However, soil compaction can be a problem in spring since the land is often not dry enough to handle the heavy wheel loads involved with certain types of spreading methods.

2) Fall application will usually result in the loss of more nutrients than spring application if the manure is not incorporated into the soil. However, fall application usually results in more time available for spreading. In addition, the soil is often quite firm and if compaction does occur, winter freezing and thawing can reduce the damage.

3) Summer application is suitable for pastures, forage crops and summer fallow.

Additional care must be exercised when applying manure to summer fallow since these fields usually release enough nitrate nitrogen during the summer to meet the next year's crop demands. Nitrates are more prone to leaching from light-textured soils. Rather than summer-fallowing these soils, producers must consider establishing a green manure crop which can utilize the nitrates.

4) Spreading of manure on snow covered or frozen land is not permitted. Spreading in the winter increases the potential of runoff to water courses. Concurrently, the nutrient loss is high and would have few benefits to the soil.

5.3 DISTANCE TO SURFACE WATER AND WELLS

It is important to consider the slope of the land and the width of buffer areas when spreading manure. As the slope increases, so does the chance that manure may run off. On steeply sloping land (greater than 15%), extra caution must be used when applying manure. It is recommended that the spreading be supervised at all times to ensure that runoff is not occurring. Sloping land must be maintained with a reasonable amount of crop cover to provide additional protection against erosion.

A buffer area is necessary to absorb the runoff and prevent it from traveling down a slope, thereby reducing the risk of runoff entering surface waters. The effectiveness of a buffer depends on factors such as land use conditions, vegetation and slope. Good judgment must be used in all cases to ensure runoff cannot enter water sources.

Private Water Supplies

A general guideline for spreading manure is to not spread on land situated less than 75 metres (250 ft) from the source of supply of water used for drinking purposes when the draining of the land is towards the water supply. Consequently, a buffer of less than 75 metres (250 ft) may be acceptable depending on the topography of the area in regards to manure spreading and grazing livestock (Public Health Regulations, 1991).

Public Water Supplies

Draft guidelines for agricultural operations and associated activities such as manure spreading within protected water supplies do not permit development, within the buffer zones as follows:

(Source: Guidelines for Preparing Development Plans for Agricultural Operations Within Protected Water Supply Areas, Government of Newfoundland and Labrador Department of Environment, Water Resources Management Division, February 1994.)

- intake pond/lake: a minimum of 150 metres (500 ft);
- river intake: a minimum of 150 metres for a distance of 1 kilometre (0.62 miles) upstream and 100 metres (328 ft) downstream;
- main river channel: a minimum of 75 metres (250 ft);

- major tributaries/lakes/ponds: a minimum of 50 metres (160 ft); and,

- other water bodies including wetlands (bogs and fens): a minimum of 30 metres (100 ft) along and around water bodies.

Buffer zones may be broadened or imposed around sensitive areas such as steep or unstable slopes, bogs, marshes or any other areas as deemed necessary by the Department of Environment. For further interpretation of these guidelines contact the Land Management Specialist, Agri-Foods Branch or the Water Resources Officer, Department of Environment.

To protect watercourses (non-water supply), manure must not be spread: (under review, these distances are measured on the horizontal)

- within a distance of 15 metres (50 ft) plus 1.5 times thepercentage of the slope; and,

- on newly cleared land within 30 metres (100 ft) of a watercourse.

Manure may only be spread on land between 15 and 30 metres (50 and 100 ft) of a watercourse if there is a naturally vegetated buffer within 0-15 metres (50 ft) of the water course.

Salmon Rivers

Buffer requirements may be greater along salmon rivers. The Environmental Assessment Act requires all development within 200 metres (660 ft) of a salmon river to be registered under the Act. Farmers must consult with the Department of Environment if contemplating expansion within 200 metres (660 ft) of a salmon river.

5.4 SENSITIVE GROUNDWATER AREAS

Both soil and groundwater conditions can be sensitive to agricultural practices which involve the application of either inorganic or organic (manure) fertilizers. Summer-fallowing is another agricultural practice that has the potential to influence surface and groundwater quality. The degree of sensitivity depends on:

- the type and depth of the overburden above an aquifer; and,

- the type of vegetation at the soil surface.

In order to prevent groundwater pollution during manure spreading, you must be careful to consider the following practices:

- care should be taken when spreading manure where the water table in shallow aquifers is near the ground surface;

- care should be taken when spreading manure in areas where very permeable soils such as coarse sand or gravel and sand are found at the surface and the water table is close to the surface;

- do not spread manure where the overburden above an aquifer is very shallow; and,

- care should be taken when spreading manure in areas where shallow bedrock occurs.

Nutrients applied to the soil surface may leach rapidly downward beyond crop rooting depths and eventually reach the aquifer. Since areas with the above noted characteristics tend to be well drained, crop vegetation is often relatively sparse and plant uptake of nutrients is low.

Where such sensitive* groundwater conditions exist, manure applications must be avoided or manure must be applied at greatly reduced rates from those recommended in Section 5.5, Application Rate. Consult a professional Agrologist for site specific recommendations in these sensitive areas before applying manure.

* *Sensitive groundwater conditions include areas where the ground water is used for drinking water (wells) and, a) the groundwater is close to the surface, or b) where the soil is very permeable and the groundwater is close to the surface, or c) where shallow bedrock orrurs.*

5.5 APPLICATION RATE

Nitrogen is usually the nutrient that limits manure application rate. The rate of application will ultimately be determined by:

- the rate at which the nutrients are used by the crop; and,

- the reserves of nitrogen in the soil.

1) Soil and manure testing is important. The application rate is often based on estimated soil and manure nutrient levels which may result in inaccuracies. These inaccuracies may lead to application rates lower or higher than required. The fertility of a field can be determined by soil testing. Ideally the manure must be tested since its nutrient content can vary depending on how the manure has been handled. The application rate can be calculated from this information, together with knowledge of the method of application, timing and soil conditions. Proper soil and manure sampling procedures are shown in Appendix H.

2) Do not over-apply manure. A moderate over-application will not immediately lead to pollution problems or crop damage, especially in dryland conditions. With excessive application rates, nitrogen and phosphorous will generally accumulate in the soil and this accumulation can be detected through subsequent soil fertility tests. If an accumulation occurs, the rate of application must be reduced accordingly. Recording the manure spreading time and rate on each field is one way to avoid long-term over-application and ensures accurate records if needed.

Tables 4, 5 and 6 provide general rates and schedules of manure applications for various crops, soil types and manure sources.

TABLE 4

Rate and Schedule of Manure Application in Tonnes/Hectare (crops over 60% legume & a sandy loam soil type)

	Early Spring			1st Cut			2nd Cut			Total		
	S	SL	L	S	SL	L	S	SL	L	S	SL	L
D1	8	11	14							8	11	14
S1	7	9	11							7	9	11
S2		5									5	
H		10									10	

Legend: D1 Dairy S1 Swine S2 Sheep H Horse

Headers: S Solid manure (tonnes), with 25% moisture content removal base from excretion.
SL Slurry manure (tonnes), (raw manure equivalent as excreted).
L Liquid manure (tonnes), with 25% dilution water by volume. To convert tonnes of liquid manure into Imperial gallons, multiply by 211; US gallons, multiply by 250.

Source: Newfoundland and Labrador Department of Forest Resources and Agrifoods.

TABLE 5

Rate and Schedule of Manure Application in Tonnes/Hectare (crops 30-60% legume and a sandy loam soil type)

	Early Spring			1st Cut			2nd Cut			Total		
	S	SL	L	S	SL	L	S	SL	L	S	SL	L
D1	20	27	34	19	25	31	5	6	8	44	58	73
S1	17	23	29	16	21	26	4	5	6	37	49	61
S2		13			11			3			27	
H		24			22			5			51	

Legend: D1 Dairy S1 Swine S2 Sheep H Horse

Headers: S Solid manure (tonnes), with 25% moisture content removal base from excretion.
SL Slurry manure (tonnes), (raw manure equivalent as excreted).
L Liquid manure (tonnes), with 25% dilution water by volume. To convert tonnes of liquid manure into Imperial gallons, multiply by 211; US gallons, multiply by 250.

Source: Newfoundland and Labrador Department of Forest Resources and Agrifoods.

TABLE 6

Rate and Schedule of Manure Application in Tonnes/Hectare (crops over 70% grass and a sandy loam soil type)

	Early Spring			1st Cut			2nd Cut			Total		
	S	SL	L	S	SL	L	S	SL	L	S	SL	L
D1	38	51	64	42	51	64	5	6	8	85	108	136
S1	32	42	53	32	42	53	4	5	7	68	89	113
S2		24			24			3			51	
H		45			45			5			95	

Legend: D1 Dairy S1 Swine S2 Sheep H Horse

Headers: S Solid manure (tonnes), with 25% moisture content removal base from excretion.
SL Slurry manure (tonnes), (raw manure equivalent as excreted).
L Liquid manure (tonnes), with 25% dilution water by volume. To convert tonnes of liquid manure into Imperial gallons, multiply by 211; US gallons, multiply by 250.

Source: Newfoundland and Labrador Department of Forest Resources and Agrifoods.

5.6 LOSSES DURING STORAGE AND APPLICATION

The nutrient content of manure (particularly nitrogen) declines during collection, storage and disposal/application. This is due to ammonia volatilization, as well as leaching and surface runoff of all soluble forms of nutrients (particularly nitrate). Proper management is important to:

- reduce nitrogen losses;
- maximize the nutrient value of the manure; and,
- minimize the potential for soil and water pollution.

Suggested management techniques include:

- using proper facilities for storage and handling (a summary of typical nitrogen losses from various storage and application systems is presented in Appendix F); and,
- applying manure to cool, moist soil in fall or early spring and incorporating it immediately when feasible. Fields in perennial forages (hay) are not plowed for the sole purpose of manure spreading.

5.7 SOIL AND CROP IMPLICATIONS

The soil characteristics of the field where manure will be spread must be known. On sandy soils, time the spreading of manure to maximize use of the nutrients by the crop. Limit the application to avoid ponding. Manure must not be applied to soil that has a moisture content greater than its field

capacity.* The soil is at field capacity if free water is visible when a handful of soil is squeezed.

The yield potential and nitrogen requirement is considerably higher on heavier textured soils than on well-drained sandy soils. In addition, the risk of groundwater pollution by the leaching of nitrates is greater on lighter textured soils than on clays. Therefore, the allowable manure application rate is higher on heavier textured soils. A practical way to determine if there is a problem with nitrate-nitrogen is to test groundwater (preferably a well) for nitrates. The Atlantic Provinces have high rainfalls and milder winters. In these areas, extensive nitrate leaching can occur after harvest to freeze-up, during extended mid-winter thaws and again in the spring. Please note, though, groundwater nitrate problems are not widespread in Newfoundland and have generally been confined to local sites within sensitive groundwater areas. In some areas manure or inorganic fertilizers have been applied at excessive rates.

There is considerable variation in the amount of nitrogen required by different crops. Forage crops such as alfalfa can utilize much more nitrogen than annual cereal crops. Alfalfa is a deep-rooted plant capable of withdrawing nitrates that may have leached out of the soils near the surface. High levels of nitrogen in the soil also presents a problem and therefore, soil testing is important to accurately assess plant requirements.

* *Field capacity is the maximum amount of water the soil can handle without any water seeping out.*

5.8 ACCEPTABLE APPLICATION RATE

Over-application of manure can lead to the following problems:

- negative effect on crops such as excessive vegetative growth, lodging, and/or delayed maturity; and,

- an accumulation of salt in the soil from some manures (periodic soil tests can monitor these situations and indicate if management adjustments are necessary).

A Method of Determining Manure Application Rates for Specific Crops

A method for calculating manure application rates is provided in Appendix I. This method uses information on the manure's composition, soil information and the nutrient needs of the crop in question to determine annual application rates and additional fertilizer requirements.

At the start of a series of annual applications to a field, 30 to 40 kg/ha (25 to 35 lb/acre) additional nitrogen fertilizer may be needed to achieve yield potentials. The reason is that not all of the manure nitrogen is available in the year of application. The nitrogen not available will be a source of residual nitrogen for crops in succeeding years.

Fields receiving annual applications of manure should be tested annually. The samples should be taken at approximately 15 cm (6 in) depth and analyzed for nitrogen, phosphorous and potassium (shallow soils in some areas of the province do not contain this much soil cover).

Consulting with a soils or crop specialist is also useful for unusual site-specific conditions (see Section 12, Sources of Information).

A Method to Determine Minimum Land Area Needed for Manure Applications

Do not to apply manure at too high a rate, particularly on coarse-textured sand and sandy loam soils which constitute about 95% of all soils in the province (see Appendix C to determine the recommended minimum land area needed for your manure). Deep rooted crops such as alfalfa, peas and vetch must be included in the crop rotation to retrieve any nitrates that may have leached down into the soil profile.

Often the costs of handling and applying manure are high, making it non- competitive on a pound-per-pound nutrient basis with commercial mineral fertilizers. However, proper periodic applications can result in substantial long-term improvements in the physical characteristics of the soil.

Field Application for Odour Control

Manure spreading is the most common cause of nuisance odour. There are many factors that contribute to the production of odours during application. Good management practices are the best method of minimizing the possibility of complaints.

5.9 MINIMIZE ODOUR

Public Relations

Neighbors are less likely to complain if they understand the problem of the odor control and why manure spreading is a critical component of farming. Neighbors will be more tolerant if they can see a genuine effort is being made to minimize odors. Some factors to consider with regard to odor control are:

- keep the barnyard, and manure storage as neat and clean as possible.
- maintain good communications with neighbors. If possible, inform your neighbors of your intentions to spread.
- keep transport equipment clean and well maintained to ensure that manure is not deposited on the road.
- if possible, avoid transporting manure on public roads during periods of high traffic. In some areas, high traffic exists no matter the time of day. However, even in these cases, peak traffic usually occurs early in the morning and late afternoon/early evening, Monday to Friday. It is noted there are other types of slow moving traffic, such as construction equipment.

Note: Livestock producers can draw one important insight from the subjective nature of odor responses. Odours from the operations of respected neighbours, trusted

friends, and valued community supporters are dramatically less objectionable than that of any evasive irresponsible individual. There clearly is a reward for the responsible community member who is appreciated by a neighbour. The reward - fewer complaints.

Weather Conditions

Weather conditions influence the intensity and duration of farm odours. Consider the following factors when deciding when to spread manure.

- Manure spread in cool or cold weather will create less odour than manure spread in warm weather.

- Wind will help dilute the odours by increased mixing in the air.

- On calm, humid days, rapid drying of the manure and dilution of the odours will not occur.

- If possible, avoid fields a short distance upwind of neighbours during sensitive weather conditions.

Note: The close proximity of forage lands to some urban areas in the Province (such as St. John's) makes it difficult to adopt minimum separation distances to residential properties or residential areas.

- Do not exceed recommended rates of application for your soil type. Generally, the period when odours are strongest is during the first 12 to 48 hours after spreading depending on temperature and weather conditions. But, with very heavy applications, odours could last up to 10 days. When spreading liquid manure in sensitive areas, apply it as thin as possible (approximately 50 m^3/ha or 5 mm thick) to maximize absorption into the soil, to enhance drying and to maintain an aerobic environment;

- Keep the discharge height of the slurry as low as possible. The higher the trajectory of discharge the greater the release of odours. Listed below are discharge methods in order from least to most effective for odour control:

  - Large gun irrigation
  - Low trajectory irrigation
  - Top discharge tanker
  - Bottom discharge tanker
  - Dribble bars or booms
  - Pump and fill tankers release less odours than vacuum filled tankers

- Where possible, incorporate manure into the soil as soon as possible after application. Tilling reduces the release of odours. If applicable,

cultivation of manure directly into the soil is an excellent method of odour control. The forage land in the St. John's area is only cultivated every few years, hence it will be seldom practical to incorporate manures in such areas.

- Particle size or droplet size of applied manure influences odour release. Small droplets have more surface area and tend to drift more.

6.0 OUTDOOR AREAS FOR DAIRY AND BEEF

Pasture Areas

Pastures are locations where livestock are primarily sustained by consuming feed growing on the area. Cattle densities in these areas are normally low, manure is therefore dispersed and available as a crop fertilizer without any further spreading.

Proper grazing of pastures can be compatible with riparian systems. Riparian areas, sometimes called shorelands, are the transition zones between land and water that line ponds, rivers, lakes, streams and marshes. (See 7.3 Riparian Areas). Grazing strategies need to be site-specific and must be developed to fit the location and the producer's operation.

Consider the following points in watering dairy and beef cattle on pasture:

- cattle may have access to natural water sources provided manure does not cause pollution and productive riparian areas are sustained;
- development of natural watering sites will ensure cattle have access to good water while limiting pollution concerns;
- whenever possible, use waterers setback from the watercourse and located to limit pollution concerns; and,
- place salt blocks and mineral licks so as to discourage loitering at watering sites and at a minimum distance of 100 metres (300 ft).

Confined Livestock Areas/Feedlots

Confined dairy areas can include outdoor, non-grazing sites where livestock are confined by fences, other structures or topography. Confined beef areas include facilities where cattle are partially or totally confined indoors, or are confined in outdoor, non-grazing sites by fences, other structures or topography. The terms commonly used are feedlots, paddocks, corrals, exercise yards, pens and holding areas. This practice is more common in the other areas of Canada than in Newfoundland and Labrador. In these other areas, livestock densities are 100 m^2 (1,000 ft^2) or less per mature animal. This is equal to 100 or more animals per hectare (40 or more animals per acre). A typical dairy operation would utilize confined livestock areas for wintering heifers and dry cows and for feeding out steers.

Please note that while this section mainly deals with cattle, these same guidelines apply for other livestock such as hogs.

Confined livestock areas require routine cleaning with all manure being spread on cropland for fertilizer. Manure stored in these areas must be managed in a manner that will not cause pollution of surface or groundwater.

6.1 SITE SELECTION

When choosing a site for a confined livestock area, you must consider the following.

- avoid sites with porous soils and/or fractured rock that would allow direct access of any contaminants to the groundwater;
- maintain recommended property separation distances as per Section 3, Site Selection. A minimum separation distance of 50 metres (160 ft) is required from any watercourse; and,
- provide adequate lot slopes and feed alley orientation to take advantage of sunlight, and use recommended stocking densities to enhance drying of the lot surface.

6.2 MANURE MANAGEMENT FOR CONFINED LIVESTOCK AREAS

Most confined livestock facilities use solid manure storage systems.

Solid Systems

Solid manure, a non-flowing material, results when the liquid portion is drained off and the manure dries, or the addition of bedding material absorbs the liquid.

(a) Bedding Packs

Many confined livestock operations in other provinces use a bedding pack. These bedding packs are often formed into mounds in pens where there is little or no slope. For well-bedded mounds, much of the liquid is absorbed, resulting in minimal seepage. Regardless of the amount of bedding, however, runoff from confined livestock areas must be contained on the operator's property. (See 6.3, Runoff Control).

A thorough cleaning once a year is recommended if a bedding pack is utilized. Thorough cleaning means the removal of manure down to the parent soil layer. Over cleaning will tend to remove the compacted and impervious soil interface layer and increase the possibility of downward nutrient movement. Cattle feedlot operators in other provinces often leave approximately 10% of the bedding pack during cleaning to retain a mound.

Manure can also be scraped from a concrete apron along the feed bunk with a front end loader. A concrete bucking wall is used to help stockpile the solid manure adjacent to a liquid holding pond. The stockpiled manure is then removed for land application.

(b) Concrete (or Hard Surfaced) Yards

Dairy cattle can also be housed in a yard area where they are fed or exercised. If less than 37 m^2 (400 ft^2) of space is provided per animal, the entire yard

should be hard surfaced.

When using concrete yards you must consider the following guidelines:

- the size of the yard area should be kept to a minimum to reduce the amount of precipitation that can mix with the manure, and to reduce the labour needed to keep the area clean;
- clean water from roofs and from the surrounding area should be diverted away from the open yard so as not to mix with contaminated water within the yard;
- runoff from the yard should be contained in a suitable holding tank, or directed to the manure storage facility; and,
- the open yard area should be cleaned regularly by scraping the manure to an appropriate storage structure suitable for either semi-solid or liquid manure, depending on the system in use on the farm. Under no conditions should cows be permitted to stand around in an area where excess manure is allowed to accumulate.

Liquid Systems

Liquid manure systems for beef operations in Canada are uncommon because of the associated high costs of the systems compared to other alternatives. However, there are dairy farms in the province which use liquid systems.

Liquid systems typically use a slatted floor barn with no bedding. Liquid manure can be stored up to six months below the slats. However, because of potentially toxic gas problems and the high cost of construction, some type of system (pumps, scrapers, etc.) is suggested to remove the manure from shallow pits below the slats to an alternate storage, such as an earthen storage or an aboveground tank.

6.3 RUNOFF CONTROL FOR CONFINED LIVESTOCK AREAS

Runoff control cannot be over emphasized in confined livestock area layout and management. The following discussion also relates to seasonal feeding areas that pose a risk to surface water. Both off-site and on-site runoff must be controlled to make the area environmentally sound. You can help to control runoff by considering the following in your design of the area:

- create diversion ditches or dikes to direct clean off-site water away from the site;
- grade the pens to allow on-site contaminated runoff to be collected in an impervious containment basin; and,
- plant grass filter strips where appropriate.

(a) Diversion Ditches/Berms

Because on-site runoff must be stored in a suitable basin, every effort to reduce the volume of off-site runoff coming onto the site will reduce the basin size and cost. All off-site runoff should, therefore, be directed away from the confined livestock area by perimeter ditches or berms. This will also keep pens drier.

(b) Grading for Runoff Control

The on-site runoff will be easy to control and will benefit cattle performance if the pens are graded during construction. A 2% to 4% diagonal slope across the pens toward the collection basin is recommended. Bedded mounds should run parallel to this diagonal slope to prevent run-off from ponding in the pens.

Runoff from a confined livestock area is directed to a collection basin, ensuring no contamination of surface water occurs. Shallow basins with large surface areas allow greater evaporation, require little maintenance and may be cropped. If a deep holding pond is necessary, the liquid can be pumped onto adjacent cropland. Collection basins should be emptied as soon as possible after major rain storms and/or spring runoff. A liner of clay or other suitable impervious material is required in porous soils and over fractured rock aquifers.

Larger feedlots often incorporate a two staged collection system consisting of a shallow settling basin and a deeper holding basin. Runoff is directed to the settling basin where the liquid portion is drained off by means of a debris fence. The liquid overflow trickles through this fence, which consists of a trash screen or narrow vertical slots, into the main holding basin.

After drying, the solids are scraped from the settling basin and spread onto cropland as fertilizer.

The storage volume of the collection basin (for rainfall and snowmelt) should be designed to hold 75 mm (3 inches) of precipitation from the collection area. If all off-site runoff is diverted away, the collection area will consist solely of the confined livestock area. Construct the basin 300 mm (1 ft) higher than the design elevation for reserve capacity.

The settling basin is not always installed but is recommended. When used, it should have a surface area about 2.5% of the collection area. The depth should be 60 to 120 cm (2 to 4 ft).

(c) Vegetative Buffers

Where there is sufficient land, suitable soil conditions and topography, a grassed

filter strip or vegetative buffer may provide sufficient infiltration to eliminate runoff and may be used as an alternative to a collection basin. A grassed strip should be at least 10 metres (30 ft) wide to be effective. Reed canary grass or orchard grass provide very effective vegetative buffers.

Please note, a vegetative buffer may not be suitable in sensitive groundwater areas (see Section 5.4, Sensitive Groundwater Areas).

7.0 FEED AND WATER FOR OUTDOOR AREAS

Livestock Waterers

Livestock waterers provide water to cattle and other livestock without affecting natural watercourses. Livestock waterers have the following advantages:

- choice of Location: Livestock waterers do not restrict the selection of feeding sites;
- livestock Control: Livestock activity can be influenced;
- protection of Natural Sources: Stream and foreshore conditions may be improved, allowing vegetation growth and reducing erosion concerns; and,
- winter Use: Livestock waterers can be frost free for a convenient all-winter water supply.

When choosing livestock waterers, the following points must be considered to ensure environmentally sound installations:

- locate livestock waterers so manure that may accumulate cannot contaminate watercourses. This will require a set back from a watercourse similar to the feeding setback of 50 metres (160 ft);
- cattle in seasonal feeding areas should be fed away from livestock waterers, encouraging manure distribution;
- locate waterers in an elevated area. Ensure adequate drainage for spillage or overflow. If the overflow water becomes contaminated it must be handled as outlined in the section on Runoff Control;
- install livestock waterers on a concrete base. A step 15 cm high (6 inches) and 45.0 mm (18 inches) wide around the waterer will prevent livestock from backing into the waterer, causing fecal contamination;
- locate waterers in such a way that they do not unduly interfere with normal cleaning operations. Manure should not be allowed to accumulate around the waterer; and,
- periodically move waterers to prevent manure buildup and trampling of the area.

Ongoing maintenance of the units is important to reducing the likelihood of problems. You must:

- check float setting for proper water level (reduce spillage);
- check for system leaks;
- clean the bowls regularly; and,

- check the power supply and thermostats (when used).

Water Fountains

(a) Electrically Heated

These are the most commonly used waterers for winter operation. In addition to specific installation requirements, safety precautions are very important. Check that the unit has been certified by the Canadian Standards Association (C.S.A.).

Waterers must be properly grounded. Ground wire in NMW cable is not guaranteed to provide sufficient protection; therefore, a separate #6 (AWG) copper wire is required from the waterer to the power source. If a metallic guard rail is constructed around the waterer, it should be grounded by a terminal welded or bolted on the rail. In order to prevent stray voltage, the concrete pad must be grounded as well. Use a qualified electrical contractor and have the installation inspected.

(b) Energy Free

The energy free (sometimes called super insulated) fountains are relatively new in the marketplace. As the name implies, these waterers do not consume electricity. A recent field study found that, provided energy free fountains are properly designed, installed and maintained, they function adequately in severe winter conditions. A minimum consumption is required to prevent freezing. In addition, daily maintenance is required to ensure ice does not build up around the drinker closures.

Cow-Powered Livestock Waterers

These livestock waterers are potentially useful on grazing areas where energy is not available. They contain a diaphragm pump operated by a lever that the cow pushes with her nose in trying to reach the waterbowl. Livestock will require some training to use this type of waterer. Some livestock, however, cannot be trained.

Solar-Powered Livestock Waterers

Pumps powered by solar energy offer another option when supplying livestock with water. These are most appropriate when common energy sources are either not available (electricity) or are expensive and inconvenient (gas and diesel fuel). Currently, the use of these devices in Newfoundland and Labrador is not widespread.

Photovoltaic solar panels (with battery backup) convert sunlight directly to DC electricity and have proven to be practical for some Canadian conditions. A number of systems are currently in operation in other provinces. Depending on the type of system used, a minimum water storage capacity of two to three days is required.

Gravity Flow

Gravity flow systems are generally used with a dugout. They have a large tank or a small, lined catchment basin located on the dugout spoil pile. This tank or basin uses gravity to feed water toa trough located in a lower area away from the water source. Water is pumped from the dugout with a gas engine, windmill or solar-powered pump. A storage system for a minimum three-day supply of water is required.

Natural Water Sources

When livestock drink directly from brooks, streams, ponds or lakes, their presence can affect the water resource. Historically there has been a lesser reliance on watering livestock from watercourses in Newfoundland and Labrador compared to the Maritimes. However, it is still important for farmers to use environmentally responsible methods to water livestock. Livestock in grazing and seasonal feeding areas can be permitted access to natural watercourses, provided that water quality is maintained at an acceptable level. Livestock in confined areas are not permitted access to natural water sources.

7.1 IMPACTS ON WATER SOURCES

Following are the concerns related to watering livestock from natural sources:

- direct deposit of manure and urine into the water while drinking increases the concentrations of nutrients, suspended solids and bacteria in the watercourse. This could contaminate the water, harm or destroy fish and/or fish spawning grounds, increase algae growth and destroy aquatic organisms; and,

- trampling of stream banks or foreshore can add to the silt content of the water, affecting fish stocks. Trampling can also destroy stream bank vegetation which is necessary to prevent erosion during high stream flows, and which provides important aquatic and wildlife habitat.

On farm watering holes, isolated ponds and intermittent water courses may be directly accessed by livestock. Watercourses, traditionally used by livestock, should be assessed to determine if there is an impact on water quality. Where impacts are significant, measures must be implemented to reduce the impact.

7.2 REDUCTION OF IMPACTS

These impacts can be reduced or eliminated by using waterers or by proper development of watering sites on natural watercourses. Undeveloped, natural sites can be made more environmentally sound if:

- loitering is discouraged by feeding and salting well away from the water;

- access to the water course is controlled by fencing;

- a gradual sloped access is chosen which can be cleaned before high stream flows;
- bank protection is added such as a rip rap (large stone), gabions (wire baskets filled with stones) or logs; and,
- gravel is added to improve footing in poor soils.

7.3 RIPARIAN AREAS

Land along the sides or banks of a watercourse is known as a riparian area. There are few such areas in Newfoundland and Labrador where exclusive grazing by livestock occurs (typically, government lease policies reserve out of the lease a minimum 15 metres [50 ft] area of land along watercourses).

It is important to preserve these areas as they are susceptible to natural processes such as flooding, deposition, erosion, droughts and land uses such as livestock grazing. The benefits of a healthy riparian area include:

- produces much more forage than uplands, often resulting in higher livestock weaning weights;
- provides livestock shelter during weather extremes in the grazing season;
- reduces flood velocities and bank erosion, minimizing property loss;
- stabilizes stream banks with dense vegetation reducing damage from animal trampling, ice scouring and erosive flood waters;
- increases late summer stream flows for stockwater, irrigation and fisheries by recharging underground aquifers and providing bank water storage;
- traps sediment, protecting water quality and reducing siltation of ponds;
- filters runoff from uphill lands;
- improves fish habitats by providing cover, food and cool water; and
- improves wildlife habitat by providing food, water and cover.

Riparian areas should:

- include trees, shrubs and grasses to help prevent bank erosion and sloughing, and to trap sediment and debris;
- have a high degree of age diversity within vegetative stand and extensive forest floor litter; and,

- have stable stream banks (no sign of bank sloughing or caving) and good vegetative cover to water's edge.

Improper riparian management reduces the amount of forage produced so cattle producers are missing an opportunity to increase their profit margin. Overused riparian areas usually mean the uplands are being under utilized, resulting in the producer losing money. Degraded riparian areas also mean loss of wildlife and fish habitat, degraded water quality and reduced property value.

Often the deterioration of a riparian area is very gradual over the lifetime of several generations of landowners. The changes may not be noticeable day to day or even year by year.

Some degraded riparian areas will respond very quickly to changes in management practices. Others will take considerably longer to return to former productivity.

Some common symptoms of a degraded riparian area are:

- few or no trees or shrubs;
- only mature trees and shrubs;
- few or no young trees and shrubs;
- limited species of vegetation (such as grasses);
- willow trees that look like mushrooms;
- raw sloughing banks;
- stream siltation;
- bare, degraded bank slopes; and,
- upland drought.

A number of factors such as vegetation type, soil and stream type, annual weather conditions, upstream use and general watershed management will affect the selection of a management strategy to improve riparian conditions.

7.4 MANAGING FOR A HEALTHY RIPARIAN AREA

Riparian areas should be viewed from a watershed/water-quality perspective while developing a grazing strategy custom-tailored for each individual operation location. Once a grazing strategy has been implemented, it is important to monitor the effects of the strategy to allow modifications as the need arises.

In general, a successful riparian grazing strategy must include the following:

- limit grazing intensity and season of use to provide sufficient rest to encourage plant vigor, regrowth and energy storage-alternate season of grazing (with the possible exception of calving pastures);

- ensure sufficient vegetation during periods of high flow to protect stream banks, dissipate stream energy and trap sediments;

- control the timing of grazing to prevent damage to stream banks when they are most vulnerable to trampling. Grazing is best when banks are dry and there has been adequate time for regrowth; and,

- develop natural watering sites or off stream waterers to limit pollution.

Proper use of a riparian area is attained when the total vegetation available is grazed at a time and intensity that does not degrade the existing riparian system, or in the case of degraded rangelands, the ability of the system to improve to a desirable state.

When designing a grazing system, remember to consider the following:

- size, shape and arrangement of the area to be grazed;

- length of grazing season;

- number of pastures required;

- water distribution;

- stocking rate;

- season of use;

- salting areas; and,

- your own needs.

The following practices must be avoided in managing your riparian areas:

- do not remove streamside shrubs, trees and other vegetation that provide bank stability, produce aquatic and wildlife habitat, reduce flood scour and contribute to bank water storage;

- do not proceed with construction/installation of bridges, culverts or alterations of watercourses without the necessary permits, notably from the Department of Environment and the Government Services Centre; and,

- avoid farming up to the edge of the stream. This removes important vegetation filter strips adjacent to streams and increases siltation of streams.

7.5 FEED

Handling and Storage

To prevent contamination of surface or groundwaters from handling and storing livestock feeds, you must follow these guidelines:

- keep feed contained on the equipment during transport;
- clean up any feed spills. This will also reduce odours and rodent activity. Layout storage sites to allow good cleanup of spillage;
- choose a well-drained storage site not subject to seasonal water flows (divert off-site runoff away from the site);
- grain should be stored in covered, vermin-proof wood or steel bins; and,
- ensure contaminated runoff is controlled and handled as outlined in the section on Runoff Control.

(a) Silage and Forage Storage

Silage juices are a significant pollution concern. If silage juice is produced, it should be collected and added to the manure storage. Proper storage and handling of silage and forages includes:

- ensuring silage moisture under 12 metres (40 ft) deep is below 65% and silage over 12 metres (40 ft) is below 60%;
- design silo floors to drain forward to the open end to prevent trapping rainwater and silage juices;
- this flow must be diverted away from watercourses and onto areas such as adjacent fields (large silos may require this flow to be drained to a liquid storage facility);
- ideally, packed horizontal silage, unpacked heap silage and bale silage must be stored on a paved or concrete floor with adequate runoff control, concrete walls and ideally, a roof or cover*; and,
- forage waste, spoilage or surplus forage must be cleaned up regularly and reused as bedding and/or incorporated in the manure storage system.

* N.B. Site conditions must be considered in designing storages. Dry sites away from watercourses may not require the same degree of containment as a poorly drained area. Furthermore, sites in close proximity to watercourses and residential areas must be carefully considered.

Silage in plastic bags should be stored under similar conditions but with the following additional considerations:

- the base should be free of sharp rocks;
- the site should be fenced to deter livestock and wildlife;
- the site should be kept free of ruts and weeds to discourage vermin; and,
- where required, the site should be baited to control vermin.

(b) Plastics

A considerable amount of plastic can be used in feed storage, such as plastic baler twine and covering for hay or silage. The best method of disposal is recycling. If recycling is not available, farm plastics (except pesticide containers) should be disposed of at an approved municipal land fill site (see Section 10.2, Disposal of Other Farm Wastes for more information).

7.6 FEEDING

Feeding losses can vary widely, but have been estimated to exceed 40% for free-access hay. While these losses are costly to cattle producers, they can also be an environmental concern.

Slant bar and tombstone feeders are designed to reduce losses due to dropped hay as cattle pull back from the feeder; however, some losses still occur. Manure will accumulate around feeders, so it is important to consider where feeders are located. Moveable feeders can be used to distribute manure, but permanent feeders will require manure to be scraped and removed.

8.0 COMPOSTING MANURE

Some farm operators in Newfoundland and Labrador are composting manures as a means of returning nutrients back to the soil. Composting is a biological process in which micro-organisms aerobically convert organic materials into a soil-like material called compost. During composting, the microorganisms consume oxygen while feeding on the organic matter. They also generate heat and large quantities of carbon dioxide and water vapour. The rate at which manure will compost depends on:

- the moisture content;
- temperature;
- level of oxygen available;
- size of the manure particles; and,
- relative quantities of carbon and nitrogen available to the microorganisms for use as food.

The optimum solids content for composting is between 40% and 50%. It is, therefore, necessary to increase the solids content of liquid waste to at least 35% before it can be composted. Fresh manure can be screened and the resulting solids, which are about 35% moisture, are composted directly. The liquid portion is collected and goes to storage. It is also possible to add some form of bulking agent, such as straw or sawdust, to adjust the moisture content before beginning composting. During the composting process, the volume of waste will be reduced by up to 50%.

An adequate supply of oxygen is required throughout the pile. To achieve this, maintain the pile at 40 to 50 percent solids and mix the material on a regular basis. This process can be carried out using either a windrow system, aerated static piles or an in-vessel system. The windrow method consists of placing the mixture of raw materials in long narrow rows (typically 1.0 to 1.2 metres high and 3.0 to 3.6 metres wide [4 by 12 feet]). The windrows are then turned on a fixed schedule to increase aeration and to rebuild the bed porosity. Aerated static piles are aerated directly with forced air systems or passive systems where pipes are placed throughout the pile to speed up the process. The in-vessel system confines the composting material within a building or container and uses forced aeration and mechanical turning to speed up the composting process.

Windrow composting generally takes from one to four months depending on the frequency of turning. In-vessel composting or aerated static piles range from two to four weeks. When managed properly, the composting process is aerobic and the release of odours must be minimal - the product will have an earthy odour. If the conditions are not controlled and the manure begins to decompose anaerobically, the compost produces very strong offensive odours and the process can take much longer.

Prevent leachate to ground and surface water through proper site selection (soils, topography), diversion of run-off from surrounding areas, including a bed of peat as a base for compost and relocating compost piles each year to minimize the accumulation of nutrients.

So far, the markets for composted manure are limited and the costs of the composting may not be recoverable in the sale of the final product. Farm operators in central areas of the province are composting a mixture of manure with peat moss. Wood chips are used for composting in areas around St. John's.

9.0 FARM RESIDENTIAL SEWAGE DISPOSAL SYSTEMS

Residential Disposal Systems are subject to the requirements of the Sanitation Regulations. For further information, obtain the document: "Standards of Accepted practice for the Location, Design and Construction of Private Sewage Disposal Systems" from the local office of the Government Service Centre.

Source: Farm Residential Sewage Disposal Systems, Jan van de Hulst, Department of Forest Resources and Agrifoods, Draft, April 1996.

10.0 DISPOSAL OF DEAD ANIMALS AND OTHER FARM WASTES

Like most business enterprises, every farm produces some type of waste material. Like manure, these waste materials must be disposed of in an environmentally acceptable manner to minimize the likelihood of contaminating soil and water. Common waste materials found on farms include:

- dead animals;
- animal health care products;
- general packaging (for example, boxes, bags, plastics);
- petroleum products such as used motor oil;
- paints and preservatives;
- pesticides;
- machinery and equipment including inert components, tires and restricted use components such as batteries;
- farm structures such as old buildings including building components;
- waste forage; and,
- waste fruit and vegetables (including organic waste dumps).

10.1 DISPOSAL OF DEAD ANIMALS

Commercial livestock operations are normally subject to mortalities and therefore generate many carcasses for disposal. Proper disposal of dead livestock is extremely important to protect the health of both people and livestock. Any animal carcass may contain bacteria and other disease organisms that can infect humans directly or through contamination of a residential water supply. Disposal of dead livestock must be in accordance with the Waste Materials Disposal Act. Mortalities must be kept in a secure and frozen state if not disposed of within 48 hours of the time of death. A secure state would be one where scavenger animals such as coyotes, wolves (in Labrador), dogs and birds, are prevented from access to the mortalities. Disposal is specified to be by delivery to a rendering plant, burial, composting or incineration.

Leaving mortalities outside for scavengers to feed on is not an acceptable method of dead animal disposal.

Rendering

Delivery of the carcasses to a rendering company is the preferred method for disposing of dead

animals. Currently, a rendering plant (Rothsay Rendering Plant) operates at Foxtrap.

Rendering companies may have certain restrictions regarding the condition of the carcass. In general, the animals must be brought in as quickly as possible in the summertime. Smaller animals that die during the winter can be frozen and delivered to the renderer at convenient intervals. Rendering companies will generally not accept dead animals that do not remain intact when handled. Depending on the end product of the rendering process, there may be restrictions on carcass quality and condition. Rendering companies that produce meat and bone meal and inedible tallow will usually accept mortalities regardless of the course of death; companies that produce an edible material may not.

If a processor is not nearby, however, the time and expense for travelling may make delivery impractical for small numbers of dead animals or farms located far away from the plant. If this is the case and if the dead animal is small in size (for example, piglets), you must freeze and store mortalities until such time as the animals can be buried or incinerated.

Fur farms in Newfoundland and Labrador accept mortalities and cull or off-sex animals as feed. Fur farmers are also feeding fish waste, meat cuttings and some wild animals killed on roadways (such as moose). Disposing of birthing mortalities is not considered a major issue in the province as adult animals often dispose of these naturally.

Burial

During the summer months, the carcass can be buried if a rendering service is not available. The Waste Materials Disposal Act prohibits the disposal of waste materials on any lands which are not waste disposal sites approved by the Government Services Centre. Place dead animals in a trench that is backfilled each time animals are added. Caution is required for burial of dead animals. While at one time carcasses could be brought to sanitary landfills, this is no longer possible in many areas. Municipalities that bury their refuse on a daily basis may allow animals to be deposited in landfill sites. Check with your local municipal office to determine if this is allowed in your area.

Ensure that the burial pit is or has:

- at least 90 metres (300 ft) from wells or domestic water intakes;
- at least 30 metres (100 ft) from any other surface water;
- constructed such that the bottom of the pit is 1.2 metres (4 ft) above the high water table;
- sized for a maximum of 700 kilograms (1,500 lb);
- hydrated lime (quick lime) to speed up decomposition and deter scavengers and insect infestation; and,
- a minimum 0.6 metre (2 ft) of soil covering the carcasses (offers protection from scavengers that will drag the carcasses around, creating both a nuisance and a possible

health hazard).

Dead animal burial pits need the approval of a Government Services Centre, Department of Government Services and Lands. Contact the regional Government Services Centre for details.

During the winter it is advisable to put dead animals in a holding area, such as a covered trailer, where they can remain frozen until burial is possible in the spring.

Composting *

Composting dead animals is becoming more popular in Canada and, as local experience is gained, it is anticipated that some farm composting facilities will beconstructed in the future. Operations using composting of mortalities must be designed and managed in such a way that they do not cause pollution. An aerobic environment must be maintained, and all material must be heated throughout to a temperature of 55ÄC (130ÄF) for at least three days for adequate reduction of pathogen levels.

Where composting is employed for dead animal disposal, they must:

- be of sufficient capacity to dispose of normal mortality rates;
- have all contaminated runoff collected, and clean surface water directed away from the composting facility;
- be located to take the farm residence and any neighbouring residences into account. While offensive odours are not usually generated in the composting process, the handling of dead livestock and compost on a daily basis may not be aesthetically pleasing. When locating a composter, consider traffic patterns required in moving dead livestock to the composter, moving the required ingredients to the composter, and removing finished compost from the composter; and,
- be situated on a well-drained site and must provide all-weather capability for access roads and work areas.

* Where this is not a common practice in Newfoundland and Labrador, such composting would be appropriate if initiated on a small scale in consultation with the appropriate agricultural and environmental agencies.
Fully composted animals, where there is no sign of bones or other materials, can be added to manure for eventual land spreading.

For the proper design of a composting facility for dead animal disposal, qualified professionals should be consulted.

Incineration

Incineration is an acceptable method of disposal if performed properly. For the dead animals to be

burnt without creating an odour problem, the temperature of the incinerator must be sufficiently high.

Where incinerators are employed for dead animals disposal, they must:

- where possible, be located so that prevailing winds carry exhaust fumes away from neighbours;
- have sufficient capacity so that all odour levels stay within tolerable limits;
- be 50 m (160 ft) minimum from wells or domestic water intakes;
- be fire safe; and,
- consume all material fed into them.

The installation and operation of any incinerator must be in compliance with the Environment Act. Generally, a single chamber-two burner type of incinerator, or equivalent, will be required. Single burner incinerators are not recommended.

For the proper design of an incinerator for dead animal disposal, qualified professionals shouldbe consulted. An incineration shall be operated to meet the maximum requirements of 0.5 hour retention time in the chamber at 1400-1600F.

Disposal

Disposal at an approved landfill site or incineration at an approved waste disposal site with the consent of the owner/operator in acceptable.

10.2 OTHER FARM WASTES

Animal Health Care Products

Spent medicines, empty containers and other items must be disposed of in an acceptable manner. For livestock producers, no approved incineration facilities for medical wastes exist. As an alternative, you must follow the following practices:

- farm medical wastes that have the potential to cut or puncture such as needles and scalpels must be packaged in rigidcontainers (forexample, a plastic container previously used for cleaning agents or windshield washer fluid) and discarded with household wastes or taken to the local Regional Veterinarian;
- return medical supplies that have outlived their shelf life (expiry date) to the supplier or to the local Regional Veterinarian.

General Packaging

Reuse or recycle farm plastics (for example, containers, silage wrap, black plastic mulch, greenhouse plastics and greenhouse transplant flats) and other packaging materials whenever possible. Packaging materials that once contained toxic materials, such as pesticides need to be disposed of as per guidelines for the disposal of pesticide containers.

Materials not reused or recycled must be disposed of at an approved municipal land-fill site or any other approved facility. Burning of plastics is also considered acceptable in Newfoundland and Labrador but only after you have contacted the Department of Environment for details.

Petroleum Products (Including Handling and Storage)

All farms use petroleum products and produce petroleum wastes such as gasoline, diesel fuel, machinery oil and hydraulic fluids. These should be stored in a double tank. Improper storage and handling of petroleum products presents a threat to public health and water quality. A few quarts of gasoline in the ground water may be enough to severely pollute your drinking water supply. At low levels, fuel contaminants cannot be detected by smell or taste but present a very real health threat. Petroleum products contain a number of potentially toxic compounds that are known carcinogens (cancer causing agents) to laboratory animals and humans.

Storage and handling of petroleum products are regulated under "The Storage and Handling of Gasoline and Associated Products Regulations" of the Environment Act. These regulations are administered by the Government Services Centre, Department of Government Services and Lands. Additional information on requirements or applications to install systems in accordance with the regulations are available from the Government Services Centre's regional offices. Disposal of unwanted waste oil and hydraulic fluids by first collecting them in either a tank or containers and then transporting them to a local oil recycling depot or a licensed waste oil collection contractor. Used motor oil can be used as a lubricant on equipment. Waste oil should not be burned unless in furnaces designed for this purpose.

Any floor drainage from a service area where oil is being used has to be routed through an oil separator before being discharged. The used waste oil floating in the separator must be removed regularly and deposited in the waste oil tank or container.

In the case of a leak or spill during petroleum storage and handling, immediately call the Environmental Emergencies 24-Hour Report Line (see Section 12). For more information, refer to the Factsheet, Storage and Handling of Petroleum Products on the Farm, Publication GT005, November 5, 1996.

Paints and Preservatives

Paints, preservatives and other materials such as adhesives and lubricants must be safely stored on farm and used up as needed, shared with a neighbour or brought to a recycling depot.

Pesticides

Pesticides can be an environmental and health hazard when used improperly. Any use of pesticides must be in accordance with The Provincial Pesticides Control Regulations (CNR 1166/96) under the

Pesticides Control Act.

You must write a Pesticide Applicator License examination administered by the PesticideControl Section, Department of Environment. Currently, no person shall store, use or apply a pesticide without an existing license of a prescribed class for that purpose unless exempt under the conditions for storing, use or application prescribed for the pesticide or unless exempted under the regulations (such as home or garden).

Pesticides may only be used if they are registered for use under the federal Pest Control Products Act.

Pesticides will be safely disposed of if you:

- triple or pressure rinse drums, glass bottles, plastic and metal containers and empty rinse liquid into sprayer;
- single rinse paper or plastic bags containers and empty rinse liquid into the sprayer;
- rinse water that cannot be added to the sprayer tank can be applied to a non-crop area which is on your property and which is at least 200 metres (656 feet) from waterbodies and wells;
- crush, puncture (several times) or damage empty containers so they cannot be reused once they have been rinsed;
- use an anti-backflow device on the pump used to fill the sprayer;
- keep an air gap between the filler hose and the top of the spray tank; and,
- discard clean, empty pesticide containers (never burn as the residues may not be destroyed and toxic fumes may be released) and then dispose of them at a landfill. Inform the landfill manager in case there is an area fomore hazardous materials. Containers may also be returned to a recycling depot, where available.

Appendix J provides a description of proper pesticide handling and storage procedures that must be followed in Newfoundland and Labrador.

Machinery and Equipment

Reuse and recycle whenever possible. If this is not possible, equipment must be collected and disposed of at an approved municipal waste disposal site or facility or to a scrap dealer.

Disposal of oil, fuel and antifreeze should be done through a licensed oil contractor. Disposal of refrigerant is regulated under the regulations for refrigerant and halons. Contact your regional Government Services Centres for information on proper disposal methods for these materials.

Farm Structures and Building Components

Building components include such materials as wood frames, glass, sheet steel, plastic, shingles. Store materials on farm for future reuse or recycling. The remaining materials must be collected and disposed of at an approved municipal waste disposal site.

Restricted use old building components include materials such as insulation, pressure heated materials, asbestos materials, composite products and treated lumber. Reuse or recycle where possible. Otherwise, the materials must be taken to an approved landfill, waste disposal site or depot for hazardous materials. For the proper disposal of asbestos, contact your regional Government Services Centre.

Waste Forage

Waste forage is a normal by-product of any livestock feeding system. It includes hay, waste silage and silage effluent.

When hay is harvested, it is allowed to dry to less than 15% moisture. When it is stored and fed, it poses no environmental hazard. In most instances, wasted hay during feeding is incorporated with the bedding and manure. It is not advisable to burn waste forages since this can cause nuisance odours and contributes to air pollution.

The potential for waste by-product from silage feeding systems also exists. However, because silage is usually harvested and stored at a much higher moisture content than hay, there is also the potential for leachate or seepage waste from the storage area. Silage seepage can have a serious impact on surface and groundwater quality and can create odours.

Management options for waste forage include:

- aim to harvest and store only as much forage as will be required for the coming year;
- recycle waste forage for hay, mulching potato land in the fall (adds organic matter and protects against soil erosion);
- harvest silage at the optimum content to minimize the potential for seepage; and,
- compost waste hay and silage, thereby making it easier to handle when applied on the land.

10.3 WASTE FRUIT AND VEGETABLES USED AS ANIMAL FEED

Many of these wastes are wet and decompose readily. Under the circumstances, problems with odour, leachate and contaminated runoff may easily develop. You can avoid these problems by practicing the following:

- if possible, process vegetable and fruit wastes into animal feed quickly to reduce

the amount of waste and decomposition and help to reduce feeding costs;

- provide the feed in a trough or receptacle that will allow the feed to be eaten rather than trampled into the ground or pen;

- do not feed canker or wart diseased potatoes, and turnips infected with clubroot to livestock to minimize the spread of disease;

- provide adequate storage facilities (preferably covered) appropriate for the material;

- locate the storage facilities away from, and where possible, downwind from neighbours; and,

- avoid water quality problems by collecting, storing and properly disposing of leachate or liquor from the stored material. It can be a highly concentrated pollutant.

11.0 ON-FARM SLAUGHTERHOUSES AND MEAT INSPECTION

Slaughter Facilities for Own Use

A number of livestock operations have their own slaughter facilities. Under the Meat Inspection Act (Newfoundland), those who slaughter their own animals on their property for their own use do not need either a facility license or individual animals inspected.

You can, however, minimize environmental and food standard problems in your facility by following guidelines for inspected facilities.

Commercial Slaughter Facilities

Under the Meat Inspection Act (Newfoundland), the slaughter of all livestock must be done in a licensed slaughterhouse. There is no exception for custom kill. The only exemptions are as indicated above (personal use) or for slaughterhouses registered under the Meat Inspection Act (Canada).

In addition to mandatory licensing, the Meat Inspection Act (Newfoundland) provides for voluntary inspection of animals before and during the slaughter process. This results in the stamping of finished product allowing easier access to retail markets.

Construction and Design

A slaughter facility must be located at a site which is free from conditions that interfere with its sanitary operation. These include but are not limited to:

- a reasonable offset from barnyards, stables, dead meat (rendering) operations, waste disposal facilities and offensive trades;
- a reasonable offset from any source of pollution or any place that harbours insects, rodents or other vermin likely to cause meat or meat products to become contaminated;
- a reasonable offset from residential property; and,
- specific regulations imposed by the Department of Environment (currently being updated).

A reasonable offset is the equivalent of 100 metres (330 ft) unless otherwise determined by the inspector for abattoirs.

In addition to proper construction, it is important that slaughterhouse facilities and equipment are operated in a manner that minimizes the chances of contamination and thereby the risks of food-borne diseases. This includes regular cleaning during and after each day's slaughter and the proper separation and disposal of condemned products.

For more information on the Meat Inspection Program and construction and operational guidelines, please contact your local Government Services Centre.

12.0 SOURCES OF INFORMATION

Provincial and Federal Agriculture

Both federal and provincial departments of agriculture are valuable sources of information to the livestock industry. Regional agricultural engineers provide engineering advice related to livestock barn design and manure management systems. The Department of Forest Resources and Agrifoods employs specialists in a variety of disciplines such as animal science, veterinary medicine, soil science and crop production. Newfoundland and Labrador agriculture staff work cooperatively with other professionals across Canada and have a wide range of publications and standard plans available on a variety of subjects. Information can be obtained from the following offices.

(a) Newfoundland and Labrador Department of Forest Resources and Agrifoods:

Soil and Land Management Division
Tel: 709-637-2081 (Director's Office, Corner Brook)
Fax: 709-637-2586

Land Use Planning
Tel: 709-729-6647/6633 (St. John's)
Fax: 709-729-6046
Tel: 709-637-2084 (Corner Brook)
Fax: 709-637-2586
Tel: 709-686 5262 (Pynns Brook)
Fax: 709-686-2491

Soil Specialist
Tel: 709-637-2986 (Corner Brook)
Fax: 709-637-2586

Soil, Plant and Feed Laboratory
Tel: 709-729-6734
Fax: 709-729-6046

Drainage Specialist
Tel: 709-637-2094 (Corner Brook)
Fax: 709-637-2586

Animal Health Division
Tel: 709-729-6879 (Director's Office, St. John's)
Fax: 709-729-0055

Food Quality Lab (St. John's)
Tel: 709-729-0388

Fax: 709-729-0055

Veterinary Diagnostic Lab (St. John's)
Tel: 709-729-6897
Fax: 709-729-0055

Production and Marketing Division
Tel: 709-637-2077 (Director's Office, Corner Brook)
Fax: 709-637-2586

Livestock Specialist (Hog and Fur)
Tel: 709-686-2702 (Pynn's Brook)
Fax : 709-686-2491

Structural and Environmental Specialist
Tel: 709-729-6868 (St. John's)
Fax: 709-729-2674

Livestock Specialist (beef and dairy)
Tel: 709-729-6827 (St. John's)
Fax: 709-729-6568
Tel: 709-686-5225 (Pynns Brook)
Fax: 709-686-5465

Regional Veterinarian
Tel: 709-729-6886 (St. John's)
Fax: 709-729-0055
Tel: 709-945-3007 (Carbonear)
Fax: 709-945-3006
Tel: 709-466-2808 (Clarenville)
Fax: 709-466-3802
Tel: 709-256-1041 (Gander)
Fax: 709-256-1044

Tel: 709-258-5335 (Bishops Falls)
Fax: 709-258-5873
Tel: 709-686-2672 (Pynns Brook)
Fax: 709-686-2491

Pest Management Specialist
Tel: 709-637-2087 (Corner Brook)
Fax: 709-637-2586

Crops Specialist
Tel: 709-729-2635 (St. John's)
Fax: 709-729-2674
Tel: 709-686-2702 (Pynns Brook)
Fax: 709-686-2491

(b) Agriculture and Agri-Food Canada:

Soil and Drainage Specialist
Tel: 709-772-4170 (St. John's)
Fax: 709-772-6064

Other Resources

The provincial and federal offices for agriculture and the environment offer a variety of publications on manure management. For more information on the subject material found in this report, please contact the following offices:

(a) Agriculture and Agri-Food Canada
Information Services (Publications)
Tel: 613-759-6626

(b) Environment Canada
Environmental Protection Service
Tel: 709-772-5488 (St. John's)
Tel: 709-637-4375 (Corner Brook)

(c) Government Service Centre:
Tel: 709-729-3699 (St. John's)
Tel: 709-466-4060 (Clarenville)
Tel: 709-256-1420 (Gander)
Tel: 709-292-4206 (Grand Falls)
Tel: 709-637-2204 (Corner Brook)
Tel: 709-896-2661 (Goose Bay)

(d) Water Resources Management Division (Protected Water Supplies)
Tel: 729-2539 (St. John's)
292-4285 (Grand Falls)
637-2367 (Corner Brook)

(e) Department of Environment Pesticide Training Officer
Pesticide Control Section
Tel: 709-729-5707 (St. John's)

A valuable supplement to this guide may be found by reference to Manure Management guides, copies of which can be found in regional agricultural offices of the Department of Forest Resources and Agrifoods.

In case of an environmental emergency, you must contact:

Environmental Emergencies 24-Hour Report Line:

Tel: 709-772-2083 (St. John's)
Tel: 1-800-563-2444 (Other Areas)

APPENDIX A

Odour Treatment Techniques

1. Examples of Exhaust Air Treatment

Scrubbers or odour absorbing filters remove the odourous compounds from the exhaust.

- **Biofilters** remove odours by biological action. The biofilter provides a medium for certain odour reducing bacteria to live;
- **Incineration** of odour compounds by passing the air through a flame; and,
- **Anti-odour agents** or masking sprays reduce the nuisance of the odour.

2. Examples of Manure Treatment

Aerobic Methods

Composting solid manure reduces odours. By mixing or ventilating, oxygen is mixed with the manure. This keeps conditions in the manure aerobic so no odours are produced. Composting can be done simply by turning a pile with a loader or in more complex vessel systems. Composted manure is more stable than untreated manure and can often be sold off the farm as a value added product.

Naturally aerated lagoons or oxidation ponds are typically large shallow ponds which rely on surface effect to keep conditions aerobic.

Mechanical agitation a liquid manure mixes air with the slurry to maintain aerobic conditions. To properly aerate a storage requires a well designed system of agitation.

Oxidation is a form of aeration where a single agitation point is used in a circular ditch to keep air mixed with the slurry.

Air Injection into the storage pit will also maintain aerobic conditions and provide agitation.

Anaerobic Methods

- **Anaerobic** ponds are one example, where crusting keeps the surface sealed; and,

- **Methane digesters** are another example of anaerobic treatment process where manure is treated in an enclosed vessel at a constant temperature which is ideal for methane production. The methane gas produced can be used as a source of energy. The treated manure has few odours.

Other Methods

Moisture Removal – By reducing the moisture level, odour production is also reduced.

Biological/Chemical Control – Bacterial culture or enzymes are added to counteract the natural odour producing process.

Chemical Masking – Chemicals can be added to manure to produce a more pleasant smell.

APPENDIX B

TABLE B.1

Converting Metric Units to Imperial

Length		Area	
1 millimetre (mm)	0.04 inch	1 square centimetre (cm^2)	0.16 square inch
1 centimetre (cm)	0.40 inch	1 square metre (m^2)	10.77 square feet 1.20 square yards
1 metre (m)	39.40 inches 3.28 feet 1.09 yards	1 square kilometre (km^2)	0.39 square mile
1 kilometre (km)	0.62 mile	1 hectare (ha)	107,636 square feet 2.5 acres
Volume		**Volume (Dry)**	
1 millilitre (ml)	0.035 fluid ounce	1 cubic centimetre (cm^3)	0.061 cubic inch
1 litre (L)	1.76 pints 0.88 quarts 0.22 gallons (Imp) 0.26 gallons (U.S.)	1 cubic metre (m^3)	1.31 cubic yards 35.31 cubic feet
		1,000 cubic metre (m^3)	0.81 acre-foot
		1 hectolitre (hl)	2.8 bushels
Weight		**Speed**	
1 gram (g)	0.035 ounce	1 metre per second	3.28 feet per second
1 kilogram (kg)	2.21 pounds	1 metre per second	2.24 miles per hour
1 tonne (t)	1.10 short tons	1 kilometre per hour	0.62 miles per hour
1 ton (t)	2,205 pound		
Pressure		**Temperature**	
1 kilopascal (kPa)	0.15 pounds/sq. in	°F = (°C x 9/5) + 32	
		°C = (°F - 32) x 5/9	

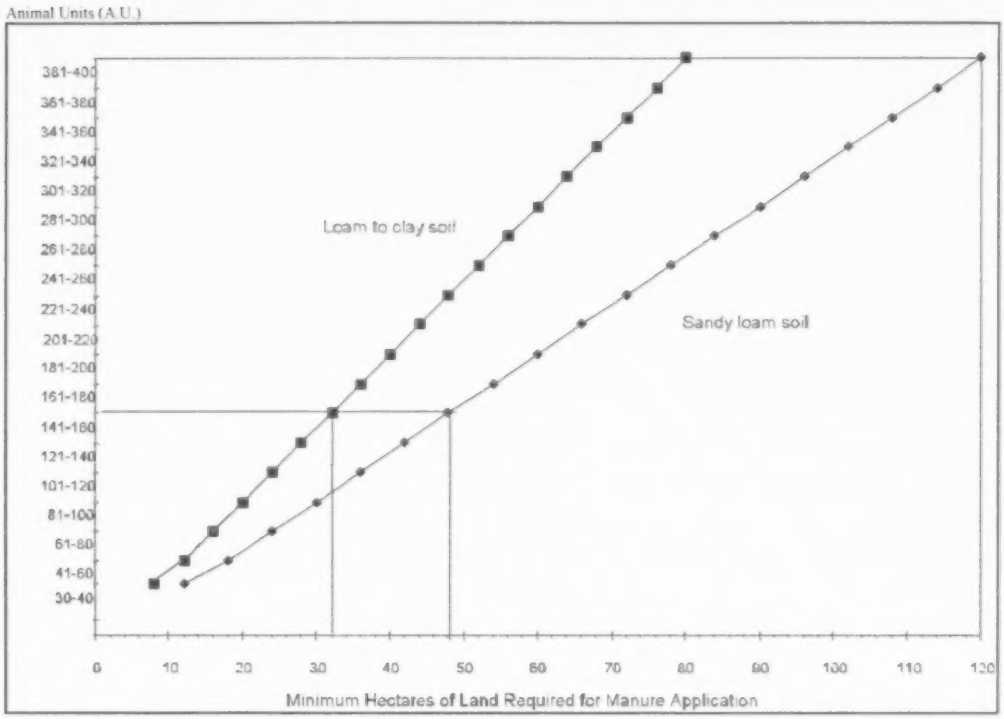
TABLE B.2

Converting Imperial Units to Metric

Length		**Volume (Dry)**	
inch	2.54 cm	cubic yard	0.76 m^3
foot	0.30 m	bushel	36.37 L
yard	0.91 m		
mile	1.61 km		
Area		**Volume (Liquid)**	
square foot	0.09m^2	fluid ounce (Imp)	28.41 millilitre (ml)
square foot	0.84 m^2	pint (Imp)	0.57 L
acre	0.40 ha	gallon (Imp)	4.55 L
		gallon (U.S.)	3.79 L
Weight		**Pressure**	
ounce	28.35 g	pounds per sq. inch	6.90 kPa
pound	453.6 g	ton	0.91 tonne

APPENDIX C

Recommended Minimum Land Area for Manure Applications



Note: For example, a farrow to finish hog operation with 160 sows (equal to 160 animal units (AU) as shown in Table C.1 [1 sow = 1 AU]) would require a minimum of 32 hectares of loam soil or 48 hectares of sandy loam soil. This is calculated by extending a horizontal line from the 141-160 AU point on the vertical axis over to the two heavy lines and then drawing another line downwards to the horizontal axis to 32 and 48 hectares, respectively. This same process can be repeated for any sized operation once the AUs have been determined from Table C.1.

TABLE C.1

Animal Unit Equivalents (A.U.)

Type of Livestock	Av. Weight Per Animal (kg)	Number of Livestock = 1 AU	Number of A.U. per Livestock
Dairy Cows	545.0-640.0	1	1.20-1.41
Heifers	300.0	2	1.30 (0.66 each)
Veal	91.0	5	1 (0.20 each)
Bulls	545.0	1	1.20
Beef Cattle	360.0	2	1.60 (0.79 each)
Sows (F to F)	454.0	1	1
Sows	150.0	3	1 (0.33 each)
Hogs	75.0	6	1 (0.165 each)
Boars	150.0	3	1 (0.33 each)
Sheep (Ewe)	54.0	8	1 (0.119 each)
Sheep (Lamb)	27.0	16	1 (0.059 each)
Goats	64.0	7	1 (0.141 each)
Foxes (w/Litter)	11.35	40	1 (0.025 each)
Mink	3.0	150	1 (0.007 each)
Rabbits	2.27	200	1 (0.005 each)

Note: One animal unit is equivalent to 454 kg (1,000 lb) live weight.

Source: Newfoundland and Labrador Department of Forest Resources and Agrifoods.

APPENDIX D

Calculating Minimum Separation Distance (MSD)

The MSD calculation in Table D.1 requires you to calculate the base distance(the value for "A" is found in Table D.2), expansion factor (the value for "B" is found in Table D.3), manure system factor (the value for "C" is found in Table D.4)) and the livestock or animal unit factor (the value for "D" is found in Table D.5).

TABLE D.1
Minimum Separation Distances (MSD)

	MSD (metres)
Nearest neighbouring dwelling	A x B x C x D
Residential, commercial or recreational areas	2 x A x B x C x D
Public buildings	3 x A x B x C x D

TABLE D.2
Base Distance as a Function of Number of Animal Units (A)

Animal Units	Base Distance (metres)
0 - 100	300
101 - 200	400
201 - 300	475
301 - 400	550
401 - 500	600
501 - 600	650
> 600	700

Adapted from Manure Management Guidelines for New Brunswick, New Brunswick Agriculture and Rural Development, Novmeber 4, 1996

TABLE D.3

Expansion Factor as a Function of % Increase (B)

% Increase *	Expansion Factor
0 - 50	0.7
51 - 75	0.77
76 - 100	0.83
101 - 150	0.91
151 - 200	0.97
201 - 300	1.04
301 - 400	1.08
401 - 500	1.11
> 500	1.14
New Operations	1.16

* % increase = (proposed AU-present AU) ÷ present AU, then x 100.

TABLE D.4

Manure System Factor (C)

Manure System	Factor
Dry litter in-situ	0.7
Solid open manure pile	0.8
Semi-solid or liquid covered concrete tank	0.8
Semi-solid or liquid open concrete tank	0.9
Semi-solid or liquid uncovered earthen tank	1.0

TABLE D.5

Livestock Factor Based on Livestock & Housing Type (D)

Manure System	Type of Housing	Factor
Dairy Cows	Tie stall	0.65
Dairy Cows	Free stall	0.7
Dairy Heifers	Barn confinement	0.7
Dairy Heifers	Barn with yard	0.8
Veal		1.0
Beef	Barn confinement	0.7
Beef	Barn with yard	0.8
Swine		1.0
Horses		0.65
Sheep		0.7
Goats		0.7
Foxes		1.1
Mink		1.1
Rabbits		0.8

For example:

1) For an existing 80 cow dairy operation with less than 50% expansion, free stall, liquid manure with an earthen manure storage:

   MSD to nearest neighbouring dwelling (A x B x C x D) = 300 (Table D.2, base distance for 0-100 animal units) x 0.7 (expansion factor of less than 40 which falls under the 0-50 category as shown in Table D.3) x 1.0 (manure system factor in Table D.4) x 0.7 (livestock factor in Table D.5) = 147 metres.

2) For a new operation using the above example:

   MSD to nearest neighbouring dwelling = 300 (Table D.2, base distance for 0-100 animal units) x 1.16 (expansion factor for new operations as shown in Table D.3) x 1.0 (manure system factor in Table D.4) x 0.7 (livestock factor in Table D.5) = 244 metres.

3) What if the expansion will add different types of livestock? In this case an appropriate expansion factor must be calculated. For example, a 100 sow farrow and 50 weaner operation (semi-solid manure) that is currently selling weaners is expanding to add an additional 500 feeder hog component.

   In this example, you must calculate the expansion factor given that the farm is adding more of a different type of livestock (in this case, feeder hogs).

   i)First, calculate the current animal units using Table D.6:

   100 sows ÷ 5.1 (see Table D.6 at the end of this example) = 19.6
   50 weaners ÷ 23 (Table D.6) = 2.2

Therefore, current animal units are 19.6 + 2.2 = 21.8 [current]

ii) Then calculate the proposed new animal units:

500 feeder hogs ÷ 6.5 (Table D.5) = 76.9 animal units [proposed]

iii) Next, calculate the % increase in animal units:

% increase = (proposed animal units + present animal units) ÷ present animal units

% increase = (76.9 + 21.8) ÷ 21.8 = 4.59 x 100 = 459% increase

iv) From Table D.3, calculate the expansion factor to use in the MSD calculation:

459% falls into the 401-500% increase category which has a factor of 1.11

v) Finally, calculate the MSD:

MSD to nearest neighbouring dwelling = 300 (Table D.2, base distance for 0-100 animal units) x 1.11 (expansion factor in Table D.3) x 0.9 (semi-solid manure system factorin Table D.4) x 1.0 (livestock factor for swine in Table D.5) = 298 metres

TABLE E.6

Animal Units (AU)
Number of Animals Required to Produce the Nitrogen to Fertilize 0.4 Hectares (One Acre) of Hay

Animal Type	Animals/Ac (@ 110 kg N/haor 44 kg/ac)
Dairy Cow (1)	0.8
Beef Cow	1.1
Beef Feeder	1.7
Sow (2)	5.1
Feeder Hog	6.5
Weaners	23
Sheep (2)	4.6
Goat (2)	4.6
Fox (3)	40 (4)
Mink (3)	80 (4)
Rabbit (3)	40 (4)

1. Includes calf until 150 kg (330 lb).
2. Includes offspring until weaned.
3. Includes offspring until market size.
4. Animal units adapted from Ontario.

APPENDIX E

Annual Livestock Manure Production

TABLE E.1

Annual Manure Production for Dairy Operations
Litres/Day (Ft^3/Day)

I. Free Stall

Dairy Type	Storage Volume/Cow in Litres/Day (and Cubic Feet/Day in Parenthesis)			
		Solid Manure Handling *		
	Semi-Solid	= Solid	+	Liquid
Cow	62 (2.2)	48 (1.7)		14 (0.5)
Heifer 0-3 mo	5 (0.2)			
Heifer 4-13 mo	20 (0.7)	17 (0.6)		3 (0.1)
Heifer 13+ mo	31 (1.1)	23 (0.8)		8 (0.3)
Milk Centre/Milking Cow	14 (0.5)			14 (0.5)

* When manure is handled as a solid there is a liquid portion (urine + flush water) that may need to be stored.

Source: Farm Practices Guidelines for Dairy Producers in Manitoba.

II. Tie Stall

Dairy Type	Storage Volume/Cow in Litres/Day (and Cubic Feet/Day in Parenthesis)		
		Solid Manure Handling *	
	Semi-Solid =	Solid +	Liquid
Cow	65 (2.3)	51 (1.8)	14 (0.5)
Heifer 0-3 mo	5 (0.2)		
Heifer 4-13 mo	20 (0.7)	17 (0.6)	3 (0.1)
Heifer 13+ mo	31 (1.1)	23 (0.8)	8 (0.3)
Milk Centre/Milking Cow	14 (0.5)		14 (0.5)

* When manure is handled as a solid there is a liquid portion (urine + flush water) that may need to be stored.

Source: Farm Practices Guidelines for Dairy Producers in Manitoba

II. Loose Housing

Dairy Type	Storage Volume/Cow in Litres/Day (and Cubic Feet/Day in Parenthesis)		
		Solid Manure Handling *	
	Semi-Solid =	Solid +	Liquid
Cow		57 (2.0)	
Heifer 0-3 mo			
Heifer 4-13 mo		17 (0.6)	
Heifer 13+ mo		23 (0.8)	
Milk Centre/Milking Cow			14 (0.5)

* When manure is handled as a solid there is a liquid portion (urine + flush water) that may need to be stored.

Source: Farm Practices Guidelines for Dairy Producers in Manitoba.

TABLE E.2

Annual Manure Production for Beef Operations
Litres/Day (Ft^3/Day)

Beef Type	Animal Weight kg (lb)	Storage Volume Per Animal in Litres/Day(and Cubic Feet/Day in Parenthesis)	
		No Bedding	Bedding
Feeder	250 (550)	15 (0.5)	18 (0.6)
	350 (770)	20 (0.7)	24 (0.8)
	450 (990)	26 (0.9)	30 (1.1)
	550 (1,210)	32 (1.1)	37 (1.3)
Cow		28 (0.9)	34 (1.2)

Source: Midwest Plan Service MWPS-18 Livestock Waste Facilities Handbook and Environmental Guidelines for Beef Producers in British Columbia (from Farm Practices Guidelines for Dairy Producers in Manitoba).

TABLE E.3

Annual Manure Production for Hog Operations
Litres/Day (Ft^3/Day)

Hog Type	Storage Volume/Animal in Litres/Day(cubic feet/day)
1 Sow, Farrow to Finish	63.0 (2.2)
1 Sow, Farrow to Weanling	23.0 (0.8)
1 Feeder Hog, Wet-Dry Feeders	5.7 (0.2)
1 Feeder Hog, Dry Feeders	7.1 (0.3)

Source: Farm Practices Guidelines for Hog Producers in Manitoba.

APPENDIX F
Nitrogen Loss Summary

TABLE F.1
Nitrogen Loss Summary for Liquid Systems

Storage[1]	% Loss[2]
Enclosed	10-20
Open	10-30
Earthen	30-50
Application	**% Loss**
Broadcast	20-30
Broadcast and Incorporate With in 24 Hrs	1-5
Sprinkler	25-35

Source: Farm Practice Guidelines for Dairy, Beef and Hog Producers in Manitoba.

TABLE F.2
Nitrogen Loss Summary for Solid Systems

Storage[1]	% Loss[2]
Enclosed	15-35
Open	20-40
Earthen	40-60
Application	**% Loss**
Broadcast	15-30
Broadcast and Incorporate Within 24 Hrs	1-5

1.Losses can vary widely depending on the climatic and management factors. The values in this table are based on typical practices.

2.Nitrogen losses after fall applications will be approximately 20% greater than spring or summer applications.

Source: Farm Practice Guidelines for Dairy, Beef and Hog Producers in Manitoba.

APPENDIX G

SAFETY

As manure decomposes, gases are released. The types of gases produced depend upon how the manure is stored. Under aerobic conditions (with oxygen present) the gases produced are not dangerous. However, when manure is stored anaerobically (no oxygen present), some of the gases produced are dangerous. When liquid manure is stored for a period of several weeks in an enclosed space, the dangerous gases can accumulate in the head space of the tank and in bubbles and dissolved gases within the manure itself. The greatest danger occurs when the manure is agitated; when this happens, the gases held in the manure are released and the concentrations can reach lethal levels within several minutes. Numerous deaths have occurred as a result of farm workers entering manure tanks and storages.

The gas that is most dangerous is hydrogen sulphide. Although it is readily detectable at low concentrations, at higher levels the gas paralyses the sense of smell, so it is possible to unknowingly encounter a dangerous situation. As the concentration increases, the hydrogen sulphide paralyses the nerves that control the diaphragm causing a person to stop breathing. When concentrations are high, a single breath of the gas can be fatal. The other gases considered to be dangerous are listed in the following table (Table G.1).

Good design and safe habits can prevent accidents from happening. Long-term storage should not be in the same air space as the animals or workers. The agitation required to remove the manure from the barn can increase gas concentrations to lethal levels very rapidly. Connections between the barn and long term storage must be separated by a gas trap to prevent the gases from returning to the barn. Design the facility so that all servicing can be performed without entering the storage.

When agitating manure in an in-barn storage, be certain to provide maximum ventilation. All personnel should work in pairs. All people should be evacuated from the air space above the storage, animals should be evacuated if possible. Begin by pumping without agitation to create several feet of head space for the gases. Agitate below the surface and do no more agitation than is necessary.

Never enter a manure tank without proper respiratory equipment that is designed for the purpose. A purpose-built breathing apparatus with full face mask and remote air tank and hose are required-**SCUBA equipment is not adequate**. Always work in pairs. If an accident does occur, apply cardio-pulmonary resuscitation (CPR) if necessary.

APPENDIX H

Soil and Manure Sampling

Soil testing for total nitrogen, phosphorous and potassium is preferably done each year to determine the kind and rate of fertilizersto be applied to get good plant growth and to prevent over application and consequently "nutrient loading" of the soil, especially nitrogen. Sampling depths of 150 mm (6 in.) for vegetable and forage production and 4 inches (100 mm) for blueberries is usuallyadequate. Soils in Newfoundland and Labrador are not analysed for nitrate-nitrogen given the rapid volatilization of nitrate-nitrogenand the non-availability of on-site testing (by the time the sample has been received by the lab, most of the nitrate-nitrogen is lost from the sample).

H.1 SOIL SAMPLING

Reliable results can only be made if the samples are fully representative of the field or area from which they were taken. In addition, proper sampling and handling procedures must be followed.

H.1.1 WHEN TO SAMPLE

Soil sampling can be done at any time, but the fall ofthe year is generally considered the best time for the following reasons:

- spring sampling tends to leave one short when requiring fertilizerand limestone recommendations for planting that year;
- fall sampling assures you that your results are returned in time for your next planting and allows for planning; and,
- early fall sampling allows you to receive results for the fall liming.

H.1.2 SELECTING AREAS TO SAMPLE

Soil sampling is normally done on an individual field basis with a single composite sample representing the whole field. Individual fields that are not uniform should be divided into smaller sampling units with a single composite sample representing each unit. The soil in each of these sampling units should have the same colour, texture, cropping history and fertilizer or manure treatments. Look for differences in slope, erosion, crop growth and yield. Any area that is different in these features and large enough to have manure applied at a different rate should be sampled separately.

Problem areas should not be sampled unless they represent a significant portion of the field. If they do, obtain separate samples. Examples of these areas include:

- bottom and uplands soil;
- large low or poorly drained areas;
- soils of different color and texture; and,
- soils of different liming, fertilizing or cropping practices.

All abnormal areas such as old manure piles, dead furrows, areas close to trees or fence lines, haystacks, corrals, fencerows or farmstead sites should also be avoided as well as locations of past chemical or fertilizer spills. Samples should not be taken along headlands, within 15 metres (50ft) of field borders or shelterbelts or within 45 metres (150 ft) of built-up roads.

If the field has been cultivated, take the sample from the compacted soil in the wheel track.

A minimum of 15 sample locations per individual field or sampling unit should be taken. A single composite sample is then formed from 15 or more samples.

H.1.3 EQUIPMENT AND SUPPLIES

Special augers or probes designed for soil sampling may be used (sample bags and information sheets are available from your local Agriculture Representative's office). However, a clean shovel or garden trowel are both equally effective.

Use two clean, labelled plastic pails for collecting samples. Information sheets, sample containers and shipping boxes are available from the lab conducting the analysis.

If a shovel is used, follow these directions:

- dig a V-shaped hole in the soil and take care to clear away the surface litter;
- take a 12 mm (½ inch) slice down one side of the hole to a depth of 150 mm (6 in.). Anywhere from 50 to 75 mm (two to three inches) is suitable for sod crops; and,
- trim both sides of the slice to leave a one inch width of soil. This is an individual sample to be placed in a clean pail. Take 5 to 10 such samples and mix them thoroughly to make a representative, composite sample.

Note: All mechanical and hydraulic samplers may yield poor samples on very dry or very wet soils. In all cases, avoid getting the topsoil in the subsoil samples, or subsoil in the topsoil samples. For example, in very dry soils, be careful not to let topsoil spill into the hole before taking deeper samples.

H.1.4 HANDLING SAMPLES

Take care to keep samples clean and uncontaminated. Clean the sampler and take a couple of dummy samples between fields.

Send samples to the laboratory as soon as possible. If a delay of more than a week is anticipated air-dry the samples. Follow these steps to dry samples:

- mix the soil in each thoroughly, breaking lumps less than 12 mm (½ in.);
- remove about 0.6 litre (1 pint) of soil and spread on a piece of clean paper;
- completely dry at a temperature of not more than 30°C. Do not dry in an oven at a high temperature since this can change the phosphorus, potassium, and

sulphur levels;

- care should be taken to avoid contamination of the samples with foreign materials such as commercial fertilizer, manure salt, baking soda, water, dust, etc. Samples should not be dried on old fertilizeror feed bags or in areas where fertilizers have been handled; and,

- a fan may be used to ensure constant air flow over samples and enhance drying.

Once the sample is thoroughly dry, fill the soil sample containers. Label each container with the correct field number and sample depth. Complete an information sheet for each field.

H.1.5 KEEPING RECORDS

It is wise to keep past records on fields sampled. The records should include:

- fertilizer and manure application rates;

- previous soil test results;

- soil condition at sampling (temperature, moisture, crop cover, etc.);

- a map of where the soil samples were taken in each field; and,

- production information.

These records may giveclues to variations in lab results from year to year, and allow for customizing manure application recommendations.

H.2 MANURE SAMPLING

The most important part of testing manures is getting a representative sample. For liquidmanures, agitate or mix the manure in the pit, lagoon, slurry store, or other storage structure before taking samples. If complete mixing is not possible, combine samples taken from 10-15 different areas within the storage pit, combine samples taken at 10-15 different times during the removal of the manure.

Mix these composites and fill a clean 0.6 litre (1 pint) plastic bottle about three-quarters full. Before sealing the bottle with its lid, squeeze the bottle to remove some of the excess air. This allowsroom for gas expansion during the shipment without excess pressure building up.

For solid manures, take samples from 10-15 different locations ofthe manure stack or pile or take samples from 10-15 loads of manure when removing and applying manures in the field. Mix thoroughly and place about 0.6 litre or 0.5 kg (1 lb) of the composite manure sample into a clean, heavy duty plastic bag and seal.

For either type of sample, refrigeratethe sample overnight or longer and send to one of the provincial laboratories. It is preferable to ship early in the week and with boxes containing adequate packing to protect the sample containers during handling. Labs willprovide sample bottles upon request. Do

not use glass bottles.

TABLE II.1

Characteristics of the Most Dangerous Manure Gases

Gas	Symbol	Density	Odour	Concentration (ppm)[1]	
				TLV-TWA [2]	Effects on Humans
Hydrogen Sulphide	H_2S	1.19	Rotten Eggs, Nauseating	10	5 - Offensive odour 150 - Olfactory paralysis, death in 30 minutes. 700 - Rapidly fatal (fatal levels commonly observed)
Carbon Dioxide	CO_2	1.53	None	5,000	30,000 - Increased breathing rate 40,000 - Drowsiness, headache 300,000 - May be fatal in 30 min. (fatal levels seldom observed)
Ammonia	NH_3	0.60	Sharp, Pungent	25	100-150 - Irrigation of eyes, nose and throat in 30 min. 5,000 - Respiratory spasm, may be fatal (fatal levels rarely observed)
Methane	CH_4	0.55	None		500,000 - Could asphyxiate (fatal levels rarely observed)

1. Ppm (parts per million) of a gas in atmospheric air; to convert to percentage by volume, divide ppm by 10,000.

2. TLV-TWA (Threshold Limit Value, Time-weighted Average), the concentration under which nearly all workers may be repeatedly exposed for an 8 h work-day and 40 hr work week without apparent adverse effects. Established by the American Conference of Government Industrial Hygienists, P. O. Box 1937, Cincinnati, OH 45201, U.S.

Source: Canada Plan Service Plan M-8710 "Manure Gas".

APPENDIX I

A Method to Determine Manure Application Rates
(Adapted from MWPS-18, Livestock Waste Facilities Handbook)

* Please note this methodology takes into account residual nitrogen in the soil from manure applications for the three previous years.

Section A. Manure Composition and Soil Information

1. Manure composition:

   a. Values from chemical analysis of manure.

Composition		Your Farm
Laboratory data are often given in ppm. To convert ppm to percent, divide by 10,000. If composition data are not available, use Table I.1 or I.2.	Total N	_____%
	Ammonium N	_____%
	Nitrate N	_____%
	P_2O_5	_____%
	K_2O	_____%

   b. Determine the amount of each nutrient per ton of solid manure or per 1,000 gal. of liquid manure. If nutrient contents are given in percent:

   ! % nutrient in manure x 20 = lb nutrients/ton; or,

   ! % nutrient in manure x 100 = lb nutrients/1,000 gal. (e.g., 0.5% Total N = 10 lb/ton or 42.5 lb/1,000 gal.).

Composition	Example (Table I.2)	Your Farm
Total N	36 lb/ 1,000 gal.	_____ lb/ ____
Ammonium N*	26 lb/ 1,000 gal.	_____ lb/ ____
Nitrate N*	-- lb/ 1,000 gal.	_____ lb/ ____
P_2O_5	27 lb/ 1,000 gal.	_____ lb/ ____
K_2O	22 lb/ 1,000 gal.	_____ lb/ ____

* If only total N is determined, assume 50% ammonium N and 5% nitrate N.

2. Soil information:

Soil Information	Example	Your Soil
Texture	Sandy loam	
Soil pH	6.2	
Available P	- lb/acre	lb/acre
Exchangeable K	- lb/acre	lb/acre

Section B. Nutrient Needs of Crop

	Example	Your Crop
Crop to be grown	Timothy	
Expected yield/acre	2.5 T	
Nutrients required/acre	N = 100 lb/acre	lb/acre
(based on soil test report or	P_2O_5 = 55 lb/acre	lb/acre
Table I.4)	K_2O = 55 lb/acre	lb/acre

Section C. Annual Rate of Manure Application

1. Calculate amount of organic N in manure (either per ton or per 1,000 gal):

lb total N - (lb ammonium N + lb nitrate N) = lb organic N

Example:

36 - (26 + -) = 10 lb organic N/1,000 gal.

Your manure:

_____ - (_____ + -) = _____ lb organic N/_____

2. Calculate amount of organic N in manure made available the first year.

lb organic N/(ton or 1,000 gal) x mineralization factor (Table I.3) =
lb available organic N/(ton or 1,000 gal)

Example:

10 x 0.35 + 3.5 lb available organic N/ 1,000 gal.

Your farm:

_____ x _____ = _____ lb available organic N/_____

3. **Calculate amount of plant-available N in manure (use either a or b below).**

   a. Incorporated application of manure (assume 25% of ammonium N is lost by volatization if knifed-in; assume no loss if immediately incorporated by other methods):

      Availableorganic N (sec C.2) + [Ammonium N (Sec A.1.b) x 0.75] + Nitrate N (Sec A.1.b) = lb plant - available N/(ton or 1,000 gal)

   Example:

   3.5 + [26 x 0.75] + - = 23 lb available N/1,000 gal.

   Your farm:

   ____+ [____ x 0.75] + _____ = _____ lb available N/_____

   b. Surface application of manure (assumes 50% of ammonium N is lost by ammonia volatilization):

      Available organic N (Sec C.2) + [Ammonium N (Sec A.1.b) x 0.50] + Nitrate N (Sec A.1.b) = lb plant-available N/(ton or 1,000 gal)

   Your farm:

   _____+ [_____ x 0.50] + _____ = _____ lb available N/_____

4. **Adjust N fertilizer recommendation to account for residual N from manure applications in the last 3 years.**

   a. Manure applied to field 1 year ago (if none, proceed to b):

      lb organic N/(ton or 1,000 gal) of manure x (mineralization factor x 0.50) x tons or 1,000 gals applied/acre = lb residual N/acre

   Example:

   10 lb/1,000 galx (0.35 x 0.50) x 6,000=10.5 lb residual N/acre

   Your farm:

   _____ x (_____ x 0.50) x _____=_____ lb residual N/acre

   b. Manure applied to field 2 years ago (if none, proceed to c.):

      lb organic N/(ton or 1,000 gal) or manure x (mineralization factor x 0.25) x tons

or 1,000 gal applied/acre = lb residual N/acre

Your farm:
_____ x (_____ x 0.25) x _____=_____ lb residual N/acre

c. Manure applied 3 years ago (if none, proceed to d.):

lb N/(ton or 1,000 gal) of manure x (mineralization factor x 0.125) x tons or 1,000 gal applied/acre = lb residual N/acre

Your farm:

_____ x (____ x 0.125) x ____ =____ lb residual N/acre

d. Total residual N:

Sec C.4.a + Sec C.4.b + Sec C.4.c = total lb residual N/acre

Example:

10.5 + - + - =10.5 total lb residual N/acre

Your farm:

_____+_____ +____=____ total lb residual N/acre

e. Adjust N requirement of crop:

lb N required by crop (Sec B) - lb residual N (Sec C.4.d) = lb N required/acre

Example:

100 - 10.5 = 89.5 lb N required/acre

Your farm:

____ - ____ =____lb N required/acre

5. Annual manure applications based on amount of N required by crop:

Adjusted N required (Sec C.4.e) ÷ lb available N/(ton or 1,000 gal) (Sec C.3.a or C.3.b) = tons of manure/acre or number of 1,000 gal units of manure/acre

Example:

89.5 ÷ 23 = 3.891 tons of manure/ac or 1,000 gal units of manure/ac

Your farm:

____ ÷ ____ = ____ tons of manure/ac or 1,000 gal units of manure/ac

6. **Annual manure application based on amount of P_2O_5 required by crop:**

P_2O_5 required by crop (Sec B) ÷ lb P_2O_5/(ton or 1,000 gal) (Sec A.1.b) = tons manure/acre or number of 1,000 gal units of manure/acre

Example:

55 ÷ 27/lb/1,000 gal = 2.037 tons of manure/ac or 1,000 gal units of manure/ac

Your farm:

____ ÷ ____ = ____tons of manure/ac or 1,000 gal units of manure/ac

7. **Select annual rate of manure to be applied. If manure is to supply all N and P_2O_5 needs of the crop, select the HIGHER of the two values (Sec C.5 or Sec C.6) as your application rate per acre. If your aim is to maximize use of nutrients in animal manure, select the LOWER of the two values, then supplement with commercial fertilizer to supply the remainder of the nutrients required by the crop.**

Rate of manure to be applied is:

Example:

2.037 tons of manure/acre

Your farm:

_____ tons of manure/acre

Section D. Additional Fertilizer Required

1. **Nitrogen (do not complete if manure rate selected in Sec C.7 supplies all of the required N).**

   a. Available N added in manure:

   Tons or 1,000 gal units of manure added/acre (Sec C.7) x lb available N/(ton or 1,000 gal) (Sec C.3.a or C.3.b) = lb available N applied

Example:

2.037 x 23 lb/1,000 gal = 46.9 lb available N applied

Your farm:

_____ x _____ = _____ available N applied

b. Additional fertilizer N required:

Adjusted N requirement (Sec C.4.e) - lb N applied (D.1.a) = lb fertilizer N required

Example:

89.5 - 46.9 = 42.6 lb fertilizer N

Your farm:

_____ - _____ = _____ lb fertilizer N

2. **Phosphorus (do not complete if manure rate selected in Sec C.7 supplies all of the required amount of P_2O_5 added in manure):**

Tons or 1,000 gal units of manure/acre (Sec C.7) x lb P_2O_5/(ton or 1,000 gal) (Sec A.1.b) = lb P_2O_5 applied

Your farm:

_____ x _____ = _____ lb P_2O_5 applied

b. Additional fertilizer P_2O_5 required:

P_2O_5 required by crop (Sec B) – lb P_2O_5 applied (Sec D.2.a) = lb fertilizer P_2O_5 required

Your farm:

_____ – _____ = _____ lb fertilizer P_2O_5 required

3. **Potassium:**

a. K_2O added in manure:

Tons or 1,000 gal units of manure/acre (Sec C.7) x lb K_2O/(ton or 1,000 gal) (Sec A.1.b) = lb K_2O applied

Example:

2,037 x 22 lb/1,000 = 44.8 lb K_2O added

Your farm:

_____ x _____ = ____ lb K_2O added

b. Additional K_2O required:

K_2O required by crop (Sec B) - lb K_2O applied (Sec D.3.a) = lb fertilizer K_2O required

Example:

250 - 44.8 = 205.2 lb fertilizer K_2O required

Your farm:

_____ - _____ = _____ lb fertilizer K_2O required

TABLE I.1

Nutrients in Solid Manure at the Time of Land Application

Species	Bedding or litter	Dry matter	Ammonium N	Total N	P_2O_5	K_2O
		%	lb/ton manure			
Swine	No	18	65	108	97	87
	Yes	18				
Beef	No	15 *	4	11	7	10
	No	52+	7	21	14	23
	Yes	50	8	21	18	26
Dairy	No	18	4	9	4	10
	Yes	21	5	9	4	10
Sheep	No	28	5	18	11	26
	Yes	28	5	14	9	25
Horse	Yes	46	4	14	4	14

Note:

* Open concrete lot.
+ Open dirt lot.

Source: MWPS-18, Livestock Waste Facilities Handbook.

TABLE I.2

Nutrients in Liquid Manure at the Time of Land Application

Species	Waste handling	Dry matter	Ammonium N	Total N	P_2O_5	K_2O
		%	lb/1,000 gal manure			
Swine	Liquid pit	4	26	36	27	22
	Lagoon *	1	3	4	2	4
Beef	Liquid pit	11	24	40	27	34
	Lagoon *	1	2	4	9	5
Dairy	Liquid pit	8	12	24	18	29
	Lagoon *	1	2.5	4	4	5
Veal calf	Liquid pit	3	19	24	25	51

Source: MWPS-18. Livestock Waste Facilities Handbook.

* Includes lot runoff water.

TABLE L3

Amount of Nitrogen Mineralized or Released From Organic Nitrogen Forms in Manure to Plant Available Forms During the Growing Season

Manure Type	Manure Handling	Mineralization Factor
Swine	Fresh	0.50
	Anaerobic liquid	0.35
	Aerobic liquid	0.30
Beef	Solid without bedding	0.35
	Solid with bedding	0.25
	Anaerobic liquid	0.30
	Aerobic liquid	0.25
Dairy	Solid without bedding	0.35
	Solid with bedding	0.25
	Anaerobic liquid	0.30
	Aerobic liquid	0.25
Sheep	Solid	0.25
Horses	Solid with bedding	0.20

TABLE L4

Estimated Removal of Plant Nutrients By Various Crops

Crop	D.M. Yield (t/ha)	Kilograms per hectare				
		Nitrogen N	Phosphorus P_2O_5	Potassium K_2O	Calcium Ca	Magnesium Mg
Oat Grain	3.1	56	22	17	3	4
Oat Straw	4.5	28	11	67	9	10
Barley Grain	3.2	56	28	17	2	3
Barley Straw	3.4	22	11	50	13	3
Wheat Grain	2.7	56	28	17	1	7
Wheat Straw	3.4	22	5	39	7	3
Corn Silage	12.3	112	56	151	12	21
Alfalfa Hay	8.9	213	50	275	132	27
Timothy Hay	8.9	151	39	163	20	11
Red Clover Hay	8.9	168	39	179	121	29

Source: Atlantic Provinces Field Crop Guide.

APPENDIX J

Guidelines for Pesticide Use

You must successfully complete a pesticide applicator examination course within Newfoundland and Labrador. Currently, no person shall store, use or apply a pesticide without an existing license of a prescribed class for that purpose and except exempt under the conditions for storing, use or application prescribed for the pesticide or unless exempted under the regulations.

Use non-chemical methods for pest control where effective and possible. For example, sanitation, biological control, crop rotation or resistant varieties. Before purchasing a pesticide, you should obtain a label and become familiar with the product. Ensure that:

- the product is registered for the intended use;
- the pesticide is suitable for use with the application equipment on your farm;
- the pesticide will work effectively under your specific farm conditions and for that specific pest;
- you know when the pesticide should be applied to be most effective;
- you have the appropriate protective clothing and equipment; and,
- you calculate and purchase only the correct amount of pesticide needed for no more than one year of use.

The following sections outline accepted guidelines for transporting, storing, applying and disposing of pesticides.

Farmers must have an Applicators Licence to purchase or apply commercial or restricted pesticides.

J.1 TRANSPORTING

When transporting pesticides you must:

- cap and pack containers securely to prevent them from leaking or being punctured or broken;
- place pesticides in a metal or plastic storage box or on a waterproof tarp to prevent leaks;
- not transport pesticides on a wooden truck bed which will absorb spilled pesticides and contaminate future loads;
- never transport pesticides with food, animal feed, fertilizer, clothing, household goods or living plants which could lead to contamination;
- lock your vehicle as you are responsible during transport if anyone is accidentally poisoned

by pesticides you have left unattended;

- protect paper or cardboard containers from rain;

- never transport pesticides in the passenger compartment of the vehicle where you or any other passenger is at risk from fumes or residues of spilled containers;

- placard your vehicle or sprayer and carry shipping papers as per the Transportation of Dangerous Goods Act for loads more than 500 kilograms (1,100 lb) of solid material, liquid formulations in containers greater than 100 litres (22 gallons) each or if carrying fumigants; and,

- carry protective clothing and gloves, clean-up materials (such as kitty litter, peat moss or other absorbent materials), plastic bags and a shovel and bucket in case of a spill.

J.2 STORAGE

Safe pesticide storage must include the following:

- you are required to store all restricted and commercial pesticides in a shed, room or locker which is locked, well ventilated, has warning signs and a source of water in or near the storage area;

- alert emergency agencies (such as the fire department) as to the location and type of hazardous chemicals stored on your farm;

- store pesticides in their original containers with original labels;

- keep herbicides separate from insecticides and fungicides;

- never store pesticides near livestock, food, animal feed, wells, water supplies, or in your home;

- ensure there is an approved fire extinguisher for chemical fires located nearby (but not in the storage area); and,

- store protective clothing and equipment near, but not in, the storage area.

J.3 MIXING AND LOADING

Spills are more likely to occur when you are mixing or loading pesticides. During mixing and loading, you must:

- put on protective clothing and safety equipment such as coveralls, rubber gloves, a waterproof hat and rubber boots, a face shield or goggles, a waterproof apron and, if necessary, a respirator (the label on the pesticides container will give you a list of the necessary protective clothing for safe mixing);

- choose a mixing site away from other people, livestock, pets and water sources when outdoors;
- ensure there is good ventilation and lighting when mixing indoors;
- always let someone know what you are mixing and make sure they are familiar with poisoning symptoms, first aid treatment and have emergency phone numbers on hand;
- keep soap, water, emergency first aid equipment and a spill clean-up kit nearby;
- mix and weigh pesticides on a sturdy level bench or table made of non-absorptive material;
- mix in still or low wind conditions outside and stand upwind of mixing areas;
- cut bags rather than tearing them;
- mix only the amount you will use immediately;
- label all measuring and mixing equipment "for pesticide use only";
- pre-mix wettable powders with a small amount of water before adding to the spray tank to prevent lumps and airborne dust;
- fill the sprayer half full with water, turn on the agitator and then slowly add the pesticide;
- rinse pesticide containers as soon as they are empty-rinse three times for empty containers which held liquids and rinse bags with solids once and then pour the rinse water into the sprayer;
- rinse all measuring equipment and replace container caps and close bags before returning them to the storage area;
- stop mixing and clean up immediately if you splash or spill any pesticide;
- use clean water with a pH of 5.0 to 7.0, if possible; and,
- leave an air gap between the end of your filling hose and the water in your spray tank to avoid contamination of the water supply.

J.4 APPLICATION

Many livestock operators in Newfoundland and Labrador have fields which are small and fragmented. Consequently, windy conditions may cause problems related to spray drift. Some pesticides also work better under specific environmental conditions. For example, synthetic pyrethroids are considered more effective in cool temperatures while others such as carbamates and organophosphates work best in warmer conditions.

During outside application, you must:

- use a calibrated sprayer suited to your needs;

- wear protective clothing;
- watch the weather and do not spray in winds stronger than a gentle breeze or no more than 2-15 kilometres per hour (for example, in the early morning or early evening);
- never apply pesticides just before a heavy rain;
- post warning signs if necessary to keep people out of treated areas;
- make sure no livestock are in the area;
- consider when honey bees or other beneficial insects are most active; and do not spray during these periods;
- apply the pesticide at the recommended rates;
- shut off spray nozzles when you turn unless you have calculated this into your spray area and want to control the pest on headlands;
- use and maintain the correct tractor speed chosen during calibration;
- plan the spray route through your field so you avoid passing through airborne spray or freshly treated areas;
- leave a buffer zone when the spraying area is next to sensitive crops or water bodies (30 metres [100 ft] around drinking wells and 10 metres [33 ft] for field boom sprayers along fish-bearing waters);
- reduce spray drift by:
  - adding a drift control agent in the spray mix;
  - setting the boom only as high as necessary for good coverage;
  - using the correct nozzle and replace worn nozzles;
  - using low pressures to produce large droplets that will still cover the plant.
- never spray when the temperature exceeds 25ÄC or if the humidity is below 50%;
- spray downwind from sensitive areas such as houses or beehives; and,
- clean application equipment well before switching pesticides (use an ammonia based bleach to the rinse water to neutralize most pesticide residue).

Be courteous to your neighbours. Where nuisance complaints are anticipated, notify neighbours of your intention to spray prior to pesticide application. This is very important where neighbours with

sensitivities live nearby (such as an asthmatic neighbour).

During inside application (for example, in greenhouses or barns), you must:

- ! follow the same appropriate safety precautions as listed for outdoor use;
- ! seal treated areas for the time specified on the label, then thoroughly ventilate before re-entry and keep people and animals away from exhaust fans during ventilation; and,
- ! place a warning sign at all entrances to the building.

APPENDIX K

REFERENCE MATERIAL

1. The Provincial Environment Act, 1995.

2. Environmental Guidelines for Producers, Province of B.C., Ministry of Agriculture and Food, 1998.

3. Pesticides Control Act, 1990.

4. Pesticide Control Regulations, Newfoundland and Labrador.

5. Public Health Regulations, 1991.

6. Guidelines for Preparing Development Plans for Agricultural Operations Within Protected Water Supply Areas, Government of Newfoundland and Labrador, Department of Environment and Lands, Water Resources Management Division, February 1994.

7. Soil Organic Matter, J.B. Whalen, Soils Specialist, Agrifoods Branch, Newfoundland and Labrador Forest Resources and Agrifoods.

8. Disposal of Household and Farm Wastes, Department of Forest Resources and Agrifoods, 1997.

9. Environmental Farm Practices Guidelines for Horticultural Producers for Newfoundland and Labrador.

10. Protected Road Zoning Regulations, under the Urban, Rural Planning Act, Newfoundland Gazette, March 27, 1997.

11. Farm Practices Guidelines for Poultry Producers in Manitoba.

12. Manure Management Guidelines for New Brunswick, New Brunswick Agriculture and Rural Development, November 04, 1996.

13. Eastern Canada Soil and Water Conservation Centre in Grand Falls, New Brunswick (506-475-4040).

14. Agriculture Department of McGill University in Ste. Anne de Bellevue, Quebec.

15. Pest Management Practices: A Manure Management Program, Ohio State University Extension, Dept. of Horticulture and Crop Science.

16. Farm Residential Sewage Disposal Systems, Jan Van de Hulst, Dept. of Forest Resources & Agrifoods, Draft, April 1996.

17. Canada Plan Service, Plan M-8710 "Manure Gas".

18. MWPS - 19, Livestock Waste Facilities Handbook.

19. Farm Practices Guidelines for Dairy, Beef and Hog Producers in Manitoba.

20. The Canadian Code for Environmentally sound Hog Production, Canadian Pork Council.

21. Environmental Guidelines for manure Storage, Newfoundland and Labrador Department of Forest Resources and Agrifoods.

22. Agricultural Engineering Department, McGill University, Ste. Anne de Bellevue, Quebec.

23. Atlantic Environmental Farm Plan, Second Edition, Atlantic Farmers Council.

24. Best Management Practices: A Manure Nutrient Management Program, Ohio State University Extension, Dept. of Horticulture and Crop Science.

25. Atlantic Provinces Field Crop Guide.

APPENDIX L

GLOSSARY OF TERMS

Pollution

Pollution is a situation where naturally occurring substances and/or contaminants in water (surface water and groundwater), soil or the air (odor and noise) exceed allowable levels and adversely affect their uses. The Provincial Environment Act (1995) defines pollution as including an alteration of the physical, chemical, biological or aesthetic properties of the air, soil or waters of the province, including a change of temperature, taste or odor, or the addition of a liquid, solid, radio-active, gaseous or other substance to the air, soil or waters, or the removal of those substances from the air, soil or waters which will render or is likely to render the air, soibr waters of the province harmful to public health, safety or welfare, or harmful or less useful for domestic, agricultural, industrial, power, municipal, navigational, recreational or other lawful uses, or for animals, birds, or aquatic life.

Groundwater

Refers to water below the surface of the ground.

Watercourse

A place that perennially or intermittently contains surface water, including a lake, brook, stream, river, spring, ravine, swamp, marsh or bog, including any drainage ditch leading into any of the foregoing.

Runoff

Overland flow of precipitation, snow melt or other liquid.

Overburden

A layer of soil, rock or other materials that ties above an aquifer and where rainwater and runoff seep into the soil to replenish the ground water.

Aquifer

A layer of rock or soil able to hold or transmit enough water to supply the needs for a water development.

Mortalities

Refer to dead poultry that are not marketable for human consumption.

Pesticides Control Act, 1990

The categories of pesticide licenses include: agriculture, aquatic, forestry, greenhouse, industrial vegetation, landscape, mosquito and biting fly, fumigation, structural and aerial. Farmers must have an Applicator's License to purchase or apply commercial or restricted pesticides. As of the writing

of this document, the use of agricultural class pesticides on an individual's own property is exempt from the requirement for an operator's license (licensing to undertake an operation designed to use a pesticide to control a pest). Individuals applying pesticides must be licensed applicators with the exception of those exempt under the Pesticide Control Regulations. For more information contact the Agrifoods Branch or the Department of Environment.

Volatilization

The process of solids or liquids turning into fumes.

Riparian Areas

Sometimes called shorelands, are the transition zones between land and water that line ponds, rivers, lakes, streams and marshes.